LOWER CRETACEOUS INOCERAMID BIVALVES FROM THE ANTARCTIC PENINSULA REGION

by J. A. CRAME

ABSTRACT. The occurrence of rich faunas of Lower Cretaceous inoceramid bivalves in the Antarctic Peninsula region further emphasizes their widespread distribution, and enhances their potential for regional biostratigraphic correlations. The Antarctic material is contained in approximately seven of twelve species groups that are recognized on a worldwide scale. Six of these are assigned to the genus *Inoceramus* and one to *Birostrina*. The comparatively rare genus, *Anopaea*, is left undivided.

In the Fossil Bluff Formation of Alexander Island, Berriasian representatives of the *I. ovatus* group (*I.* cf. *ovatus* Stanton and *I.* sp. aff. *ellioti* Gabb) are succeeded by *A. trapezoidalis* (Thomson and Willey) which has undifferentiated Berriasian–Aptian affinities. This is in turn followed by an Aptian member of the *I. neocomiensis* group (*I. deltoides* sp. nov.) and in the Albian there are occurrences of *Anopaea* sp. nov. aff. *mandibula* (Mordvilko), *B.*? cf. *concentrica* (Parkinson) (*B. concentrica* gp.), *I.* cf. *anglicus elongatus* Pergament, *I.* sp. aff. *bellvuensis* Reeside, *I.* sp. aff. *comancheanus* Cragin (all *I. anglicus* gp.), and *I. flemingi* sp. nov. (*I. liwerowskyae* gp.). Aptian–Albian strata on James Ross Island have yielded both *I. stoneleyi* sp. nov. (*I. liwerowskyae* gp.) and *Anopaea* sp. nov. β. These are followed by the Albian species *I.* cf. *sutherlandi* M'Coy and *I. carsoni* M'Coy (both *I. carsoni* gp.) and the highest Lower Cretaceous specimens within this sequence have been referred to *B. concentrica* (Parkinson).

Although specimens of *I.* cf. *heteropterus* Pokhialainen (*I. heteropterus* gp.) and *I. annenkovensis* sp. nov. (unclassified) from Annenkov Island are of probable Hauterivian–Barremian age, it is noticeable that there is a marked lack of Valanginian–Barremian inoceramids in the Antarctic Peninsula region. This gap probably reflects a period of regional uplift and non-deposition.

Representatives of the *I. ovatus* and *I. heteropterus* groups provide a means of correlation between the Berriasian–Barremian of the Antarctic Peninsula and the North Pacific region. *I. deltoides* sp. nov. can be closely matched with Northern Hemisphere Aptian members of the *I. neocomiensis* group and *I. stoneleyi* sp. nov. and *I. flemingi* sp. nov. have possible counterparts within the Aptian–Albian of Spitzbergen, south-east USSR and far eastern USSR. Of the various Albian species groups, that based on *I. carsoni* provides a direct link between Antarctica and Australia and those based on *I. anglicus* and *B. concentrica* facilitate a range of long-distance correlations. The latter category, in particular, may be one of the first truly cosmopolitan inoceramid groups.

IN comparison with their Upper Cretaceous counterparts, Lower Cretaceous inoceramid bivalves have received little attention from palaeontologists. It is usually assumed that a few meagre lineages persisted from the Jurassic–Cretaceous boundary through to the beginning of the Upper Cretaceous, when a remarkable diversification occurred. In an early paper on the evolution of *Inoceramus* through the period, Woods (1912) depicted the entire range of English Upper Cretaceous species as originating from just two Aptian species. Possible Neocomian (i.e. Berriasian–Valanginian) and Barremian ancestors were not considered.

We now know that there was in fact a considerable diversity of Lower Cretaceous inoceramids. In the Neocomian they can be traced around the North Pacific margins from California to Kamchatka (Pokhialainen 1974) as well as in Northern Siberia (Zakharov 1966; Zakharov and Turbina 1979) and parts of Europe (Gillet 1924). In the Barremian–Aptian there is a notable development of the *I. neocomiensis* group, and in the Albian a variety of species is known from regions such as the North Pacific (e.g. McLearn 1943; Imlay 1961; Pergament 1965), the Russian Platform (Savelicv 1962), Western Europe (e.g. Woods 1911), and Australasia (e.g. Day 1969; Stevens and Speden 1978). The distribution of Lower Cretaceous *Inoceramus* species would seem to be such as to offer considerable potential for regional biostratigraphic correlations.

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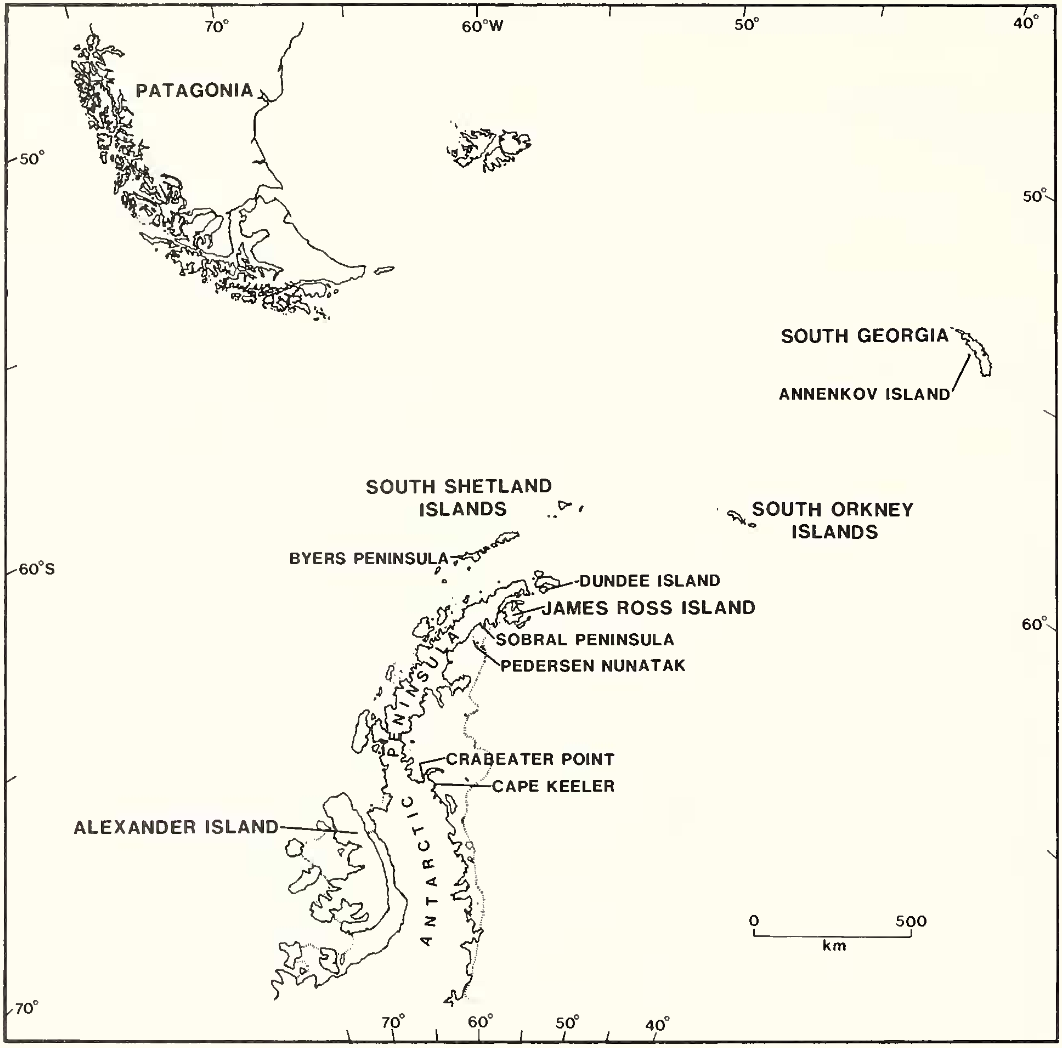
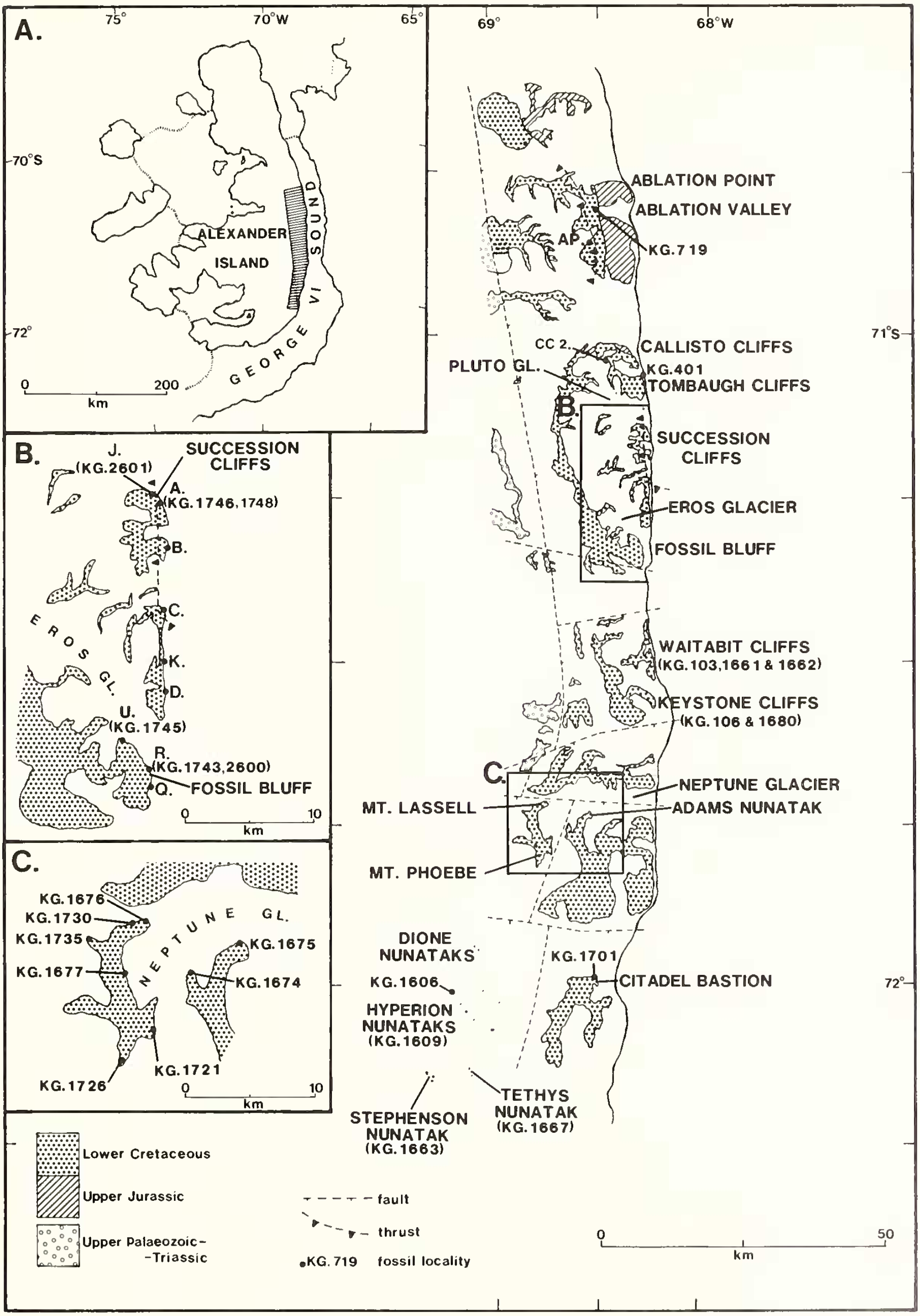
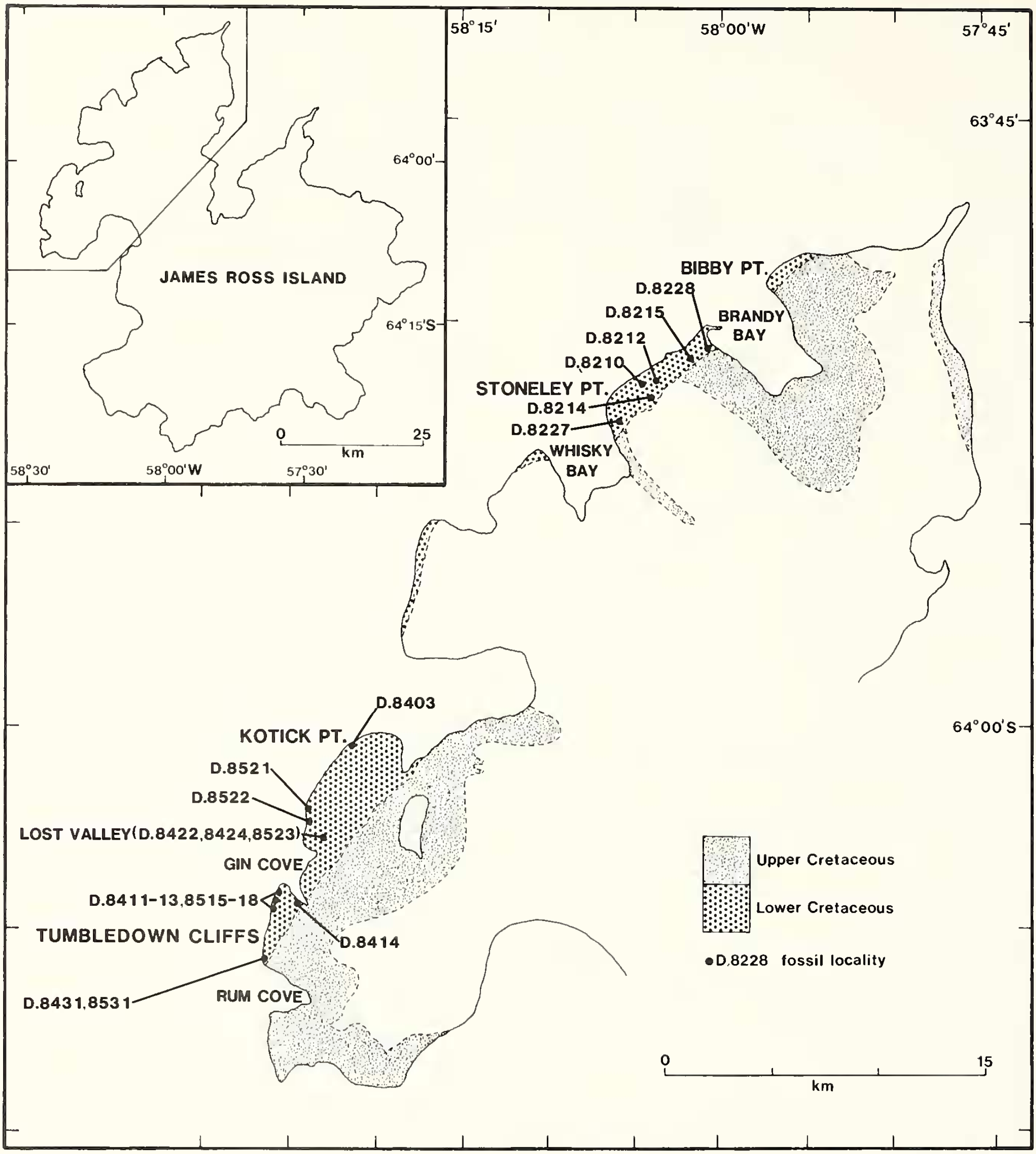


TEXT-FIG. 1. Locality map for the Antarctic Peninsula region.

One further region in which Lower Cretaceous inoceramids are well represented is the Antarctic Peninsula (text-fig. 1). On the south-western flanks of the peninsula, along the inner or eastern margin of Alexander Island (text-fig. 2), they occur through the greater part of the Fossil Bluff Formation (?Kimmeridgian–Albian). This unit, which is at least 4 km thick and composed of a variety of fine- to coarse-grained volcaniclastic sediments, accumulated in a fore-arc environment (Taylor *et al.* 1979). On the north-eastern side of the peninsula, within the James Ross Island group (text-fig. 3), further Cretaceous sediments are encountered that were deposited in a rear-arc setting. Recent fieldwork has shown the lower stratigraphic units mapped by Bibby (1966) in this area to be lower Cretaceous. They are approximately 1400 m thick, and are composed of lithologies ranging from bioturbated siltstones to breccio-conglomerates, and contain both ammonites and inoceramids. They pass up into a predominantly finer grained Upper Cretaceous sequence (the Hidden Lake Beds and Snow Hill Island Series of Bibby, 1966), that may be in excess of 3 km thick. Further fossiliferous Cretaceous sediments



TEXT-FIG. 2. Locality and geological map of the central east coast of Alexander Island. The Fossil Bluff Formation comprises the Upper Jurassic and Lower Cretaceous strata. Inset A shows the position of the enlarged area on the east coast of Alexander Island, inset B is an enlargement of localities in the Succession Cliffs–Fossil Bluff area, and inset C of localities in the Adams Nunatak–Mt. Lassell–Mt. Phoebe area.



TEXT-FIG. 3. Locality and geological map of NW James Ross Island. The inset shows the position of the enlarged area on the NW coast of James Ross Island.

can be traced through the Scotia arc in both the South Shetland Islands and the South Georgia Island group. In the former of these areas, early Cretaceous fossils have been collected from a sequence of fine- to coarse-grained clastic sediments on Byers Peninsula, Livingston Island (text-fig. 1) (Smellie *et al.* 1980). These sediments are intimately associated with a series of contemporaneous island-arc volcanic rocks in a setting similar to that described on Annenkov Island, close to South Georgia (text-fig. 1) (Pettigrew 1981). Indeed, similar fossiliferous Lower Cretaceous sediments associated with volcanic rocks can be traced into the regions of southern Patagonia that were once contiguous with the island-arc marginal basin systems of the Scotia arc (e.g. Tanner *et al.* 1981; Tanner 1982).

It is the aim of this paper to describe the Lower Cretaceous inoceramids from the Antarctic Peninsula region and assess their potential for both local and regional biostratigraphic correlations. Until a formal re-classification has been completed (Crame, in prep.), it will be necessary to divide the two principal genera (*Inoceramus* J. Sowerby, 1814 and *Birostrina* J. Sowerby, 1821) into a series of informal species groups (Table 1). These groups are partly based on those of previous authors (Woods 1911, 1912; Gillet 1924; Maury 1936; McLearn 1943; Hayami 1960; Saveliev 1962; Pergament 1965; Sornay 1966; Pokhialainen 1969, 1974) and are partly new herein. *Inoceramus* is subdivided into nine species groups and *Birostrina* (which is here taken to be a valid genus, *sensu* Kauffman 1977, 1978*a–c*) into three. In Table 1 these twelve categories are arranged in approximate stratigraphic order. The comparatively rare genus, *Anopaea* Eichwald, 1861, is left undivided.

Wherever possible, the following measurements were taken:

shell length (L)—the length of the valve as measured along the direction of maximum growth (or growth axis).
shell width (W)—the maximum dimension perpendicular to the length.
apical angle (α)—the angle between the hingeline and the anterior margin.

All the specimens are currently held in the collections of the British Antarctic Survey, Cambridge, UK. In the systematic descriptions the following abbreviations are used: WS—whole specimen (i.e. bi-valved specimen); LV—left valve; RV—right valve.

SYSTEMATIC PALAEONTOLOGY

Family INOCERAMIDAE Giebel, 1852
Genus INOCERAMUS J. Sowerby, 1814

Type species. Inoceramus cuvierii J. Sowerby, 1814 from the 'Upper Chalk' of Sussex, England; by subsequent designation (Cox 1969, p. N315).

Inoceramus ovatus group
Inoceramus cf. *ovatus* Stanton, 1895

Text-fig. 4*a*

cf. 1895 *Inoceramus ovatus* Stanton, p. 47, pl. 4, fig. 15.
cf. 1938 *Inoceramus ovatus* Stanton; Anderson, p. 99, pl. 4, fig. 9.
cf. 1966 *Inoceramus ovatus* Stanton; Zakharov, p. 98, pl. 35, fig. 3.
1972 *Inoceramus* sp. α, Thomson and Willey, p. 9, fig. 7*c*.

Holotype. Inoceramus ovatus Stanton (1895, p. 47, pl. 4, fig. 15); Paskenta group (Berriasian–Valanginian), Shasta series, California (see Anderson 1938); by monotypy.

Material. One slightly distorted internal mould (WS) KG.719.15) from approximately the 1675 m level in the Ablation Valley section, Alexander Island (70° 49′ S., 68° 28′ W.; text-figs. 2 and 10).

Occurrence. As for material; specimen KG.719.15 occurs in association with a Berriasian *Haplophylloceras–Bochianites* ammonite assemblage (Thomson 1979, p. 31); Tithonian–Valanginian (and Hauterivian?) range established in the Northern Hemisphere.

Description. The left valve (text-fig. 4*a*), which is the better preserved of the two, clearly has a subsymmetrical pyriform outline; the narrow, pointed umbonal region is curved gently forwards and there are well-rounded anteroventral, ventral, and posteroventral regions. The length of the valve is 62 mm and width is 45 mm (W/L = 0·73). It is moderately convex, with the maximum inflation occurring in the umbonal region and centre of the valve. There are steep descents to the antero- and posterodorsal regions, but much shallower gradients in a ventral direction. Ornament consists of

TABLE 1. Classification of Lower Cretaceous inoceramids. The table summarizes the morphological features, and stratigraphical and geographical distributions of the principal Lower Cretaceous species. The genera *Inoceramus* and *Birostrina* are subdivided into informal species groups and it is envisaged that these will eventually form the basis of a series of subgenera. References used in establishing the various categories are as follows:

Inoceramus ovatus gp.: Whiteaves 1883; Stanton 1895; Anderson 1938, 1945; Zakharov 1966, 1968; Pokhialainen 1974; Zakharov and Turbina 1979. *I. proconcentricus* gp.: Zakharov 1966; Pokhialainen 1969; Zakharov and Turbina 1979. *I. aucella* gp.: Trautschold 1865; Hayami 1960; Pergament 1965; Pokhialainen 1969, 1974; Glazunova 1973. *I. colonicus* gp.: Anderson 1938; Imlay 1960; Pergament 1965; Zakharov 1968; Pokhialainen 1969, 1974; Jeletzky 1970. *I. heteropterus* gp.: Whitehouse 1924; Anderson 1938; Imlay 1960; Jones and Gryc 1960; Pergament 1966; Pokhialainen 1969; Kauffman *et al.* 1978. *I. neocomiensis* gp.: d'Orbigny 1846; Whiteaves 1883; Wollemann 1906; Woods 1911; Gillet 1924; Weaver 1931; Hayami 1960; Imlay 1960; Casey 1961; Sornay 1965; Pokhialainen 1969; Glazunova 1973; Zakharov and Turbina 1979. *I. liwerowskyae* gp.: Newton 1909; Stolley 1912; Wellman 1959; Saveliev 1962; Pergament 1965; Glazunova 1973. *I. anglicus* gp.: Woods 1911, 1912; McLearn 1919, 1933, 1943; Reeside 1923; Imlay 1961; Saveliev 1962; Pergament 1965; Glazunova 1973; Jeletzky 1977; Kauffman 1978*a–c*, Kauffman *et al.* 1978; Matsumoto *et al.* 1978. *I. carsoni* gp.: M'Coy 1865, 1866, 1867; Etheridge 1872; Etheridge Jr. 1892, 1901, 1905; Ludbrook 1966. *Birostrina salomoni* gp.: Woods 1911, 1912; Casey 1961; Saveliev 1962; Kauffman 1978*a*. *B. concentrica* gp.: J. Sowerby 1821; Etheridge 1907; Woods 1911, 1912, 1917; Heinz 1930; Maury 1936; Nagao and Matsumoto 1939; Warren and Stelck 1940; Saveliev 1962; Pergament 1966; Glazunova 1973; Kauffman 1977, 1978*a–c*; Speden 1977; Wiedmann and Kauffman 1978; Crame 1980. *B. sulcata* gp.: Parkinson 1819; J. Sowerby 1821; d'Orbigny 1846; Wollemann 1906; Woods 1911, 1912; Jones 1960; Kauffman 1978*a–c*. *Anopaea* (undivided): Etheridge Jr. 1901; Saveliev 1962; Pokhialainen 1969; Thomson and Willey 1972; Crame 1981; Kelly 1984.

Genus and group name	Component species	Diagnostic features	Stratigraphic range	Distribution
Inoceramus ovatus gp	*I. ovatus* Stanton, *I. ellioti* Gabb, *I. quatsinoensis* Whiteaves, ?*I. impurus* Zakharov, ?*I. carinatus* Zakharov, ?*I. bojarkaensis* Zakharov, ?*I. golberti* Zakharov and Turbina (pars)	Small to medium; oval to pyriform outline; generally erect but may include some obliquely elongated forms; only slightly inequivalve; weakly to moderately inflated; subdued or irregular concentric ornament	Tithonian–Valanginian; ?Hauterivian	Pacific Coast of USA; northern Siberia
I. proconcentricus gp.	*I. proconcentricus* Pokhialainen, *I. murgalensis* Pokhialainen, *I. pronatus* Pokhialainen, *I. taimyricus* Zakharov, *I. vassilenkovi* Pokhialainen, ?*I. apiatus* Pokhialainen	Small to medium; oval to well rounded; moderately to strongly inequivalve; most gryphaeoid forms bear superficial resemblance to *Birostrina concentrica*; weakly to moderately inflated (LV always more convex); subdued to prominent, irregular concentric ornament	Berriasian–Valanginian; Lower Hauterivian	Far East of USSR; northern Siberia
I. aucella gp.	*I. aucella* Trautschold, *I. pseudopropinguus* Pergament, ?*I. maedae* Hayami, ?*I. gagaensis* Pokhialainen	Medium; pyriform to rounded-elongate; LVs sometimes have angular (almost trapezoidal) outline; moderately to strongly inequivalve; moderately inflated (LV more than RV); LV umbo only moderately enrolled; broad, low, regular concentric folds	Essentially Upper Hauterivian; possibly some extension into both the Lower Hauterivian and Lower Barremian	Far East of USSR, Japan; Pacific Coast of North America; Spitzbergen; Russian Platform; Crimea; northern Siberia
I. colonicus gp.	*I. colonicus* Anderson, *I. ovatoides* Anderson, *I. subcolonicus* Pokhialainen	Medium to large; pyriform to rounded-elongate; strongly gryphaeoid; LV always much more inflated than RV; narrower than *I. aucella* or *B. concentrica*; long, narrow RVs have 'pinnid' appearance; long, curving ligamentat; almost smooth	Upper Hauterivian–Lower Barremian	Far East of USSR; Pacific Coast of North America

I. heteropterus gp.	*I. heteropterus* Pokhialainen, *I. semicostatus* Pokhialainen, *I. peltiformis* Pokhialainen, *I. solus* Pokhialainen, *I. terechovae* Pokhialainen, ?*I. vallejoensis* Anderson, ?*I. dunveganensis* McLearn, ?*I. scutulatus* Whitehouse, ?*I. procerus* Whitehouse	Medium to large; rounded, rounded-triangular, or oval outline; tapering dorsally; prominent narrow, pointed beaks rise slightly above hingeline and curve forwards; moderately inflated; slightly inequivalve ?; RV often with steep, shelf-like anterior margin; prominent ligamentat bearing large rounded-rectangular resilifers; almost smooth or faint, broad, concentric ribs	Essentially Upper Hauterivian; if *I. vallejoensis* is a true member, then range may extend down into the Valanginian; if *I. dunveganensis*, *I. scutulatus*, and *I. procerus* are true members, then the range may be extended up to the Upper Albian, and possibly even Middle Cenomanian	Far East of USSR; ?Antarctic Peninsula; possible extension to Japan; Pacific Coast of North America; north-east Australia
I. neocomiensis gp.	*I. neocomiensis* d'Orbigny, *I. subneocomiensis* Glazunova, *I. volgensis* Glazunova, ?*I. quatsinoensis* Whiteaves, ?*I. ewaldi* Schluter, ?*I. curacoensis* Weaver, ?*I. borealis* Glazunova, ?*I. obtusus* Glazunova, ?*I. gusselkaensis* Glazunova, ?*I. pochialaynen* Zakharov and Turbina	Small to medium; broad, rounded-triangular outline; weakly to moderately inflated; LV slightly larger and more convex than RV; straight anterior margin; apical angle approx. 95°–115°; narrow, closely and evenly spaced ribs which occasionally split or become irregular; ribs have acute to rounded summits and are sometimes superimposed on primary low folds	Barremian–Aptian, with a possible downward extension into Hauterivian and Valanginian	Europe; south-western USSR; ?Far East of USSR; Pacific Coast of North America, southern Argentina
I. liwerowskyae gp.	*I. liwerowskyae* Saveliev, *I. kedroviensis* Pergament, *I. choffati* Newton, *I. spitzbergensis* Stolley, *I. saratoviensis* Glazunova, ?*I. urius* Wellman	Small, erect, rounded-triangular to rounded-quadrate outline; equivalve; moderately to strongly inflated in centre of valve and umbonal region, often flattening towards valve margins; prominent, prosogyrous beaks; faint, narrow concentric ornament which may become irregular ventrally; occasional coarse ribs with acute summits may also develop ventrally	Upper Aptian to Middle or Upper Albian	South-western USSR; Far East of USSR; Spitzbergen; South Africa; ?New Zealand
I. anglicus gp.	*I. anglicus* Woods, *I. subanglicus* Pergament, *I. anglicus elongatus* Pergament, *I. anglicus conjugulis* Pergament, ?*I. dowlingi* McLearn, ?*I. cadottensis* McLearn, ?*I. comancheanus* Cragin, ?*I. bellvuensis* Reeside	Small to very large; broad rounded to rounded-triangular outline; length approximately equal to width; anterior region more prominent and apical angle larger than in *I. neocomiensis* group; weakly inflated; slightly inequivalve ?; narrow, regular concentric ribs usually have well-rounded summits and are separated by broad, flat interspaces; ribs typically symmetrical about growth axis and occasionally weaken or bifurcate	Essentially Middle–Upper Albian, but may also range into both Lower Albian and Lower Cenomanian	Europe; south-western USSR; Far East of USSR; Japan; Pacific Coast of North America; East Greenland; eastern Mexico
I. carsoni gp.	*I. carsoni* M'Coy, *I. sutherlandi* M'Coy	Medium to very large; sub-erect to strongly obliquely elongated; both narrow and broad forms exist; equivalve to slightly inequivalve ?; moderately to strongly inflated over the umbonal region but flattened ventrally; pointed umbonal region strongly projecting; anterior margin often in the form of a shallow sigmoidal curve; narrow, regular concentric ornament which may be in two distinct phases	Upper Albian	North-east Australia

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Genus and group name	Component species	Diagnostic features	Stratigraphic range	Distribution
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I. aucella gp.	*I. aucella* Trautschold, *I. pseudoprupinguus* Pergament, ?*I. inaedae* Hayami, ?*I. gagarensis* Pokhialainen	Medium; pyriform to rounded-elongate; LVs sometimes have angular (almost trapezoidal) outline; moderately to strongly inequivalve; moderately inflated (LV more than RV); LV umbo only moderately enrolled; broad, low, regular concentric folds	Essentially Upper Hauterivian; possibly some extension into both the Lower Hauterivian and Lower Barremian	Far East of USSR, Japan; Pacific Coast of North America, Spitzbergen, Russian Platform; Crimea, northern Siberia
I. colonicus gp.	*I. colonicus* Anderson, *I. ovatoides* Anderson, *I. subcolonicus* Pokhialainen	Medium to large, pyriform to rounded-elongate; strongly gryphaeoid; LV always much more inflated than RV; narrower than *I. aucella* or *B. concentrica*, long, narrow RVs have 'pinnid' appearance; long, curving ligamentat; almost smooth	Upper Hauterivian–Lower Barremian	Far East of USSR, Pacific Coast of North America
I. heteropterus gp.	*I. heteropterus* Pokhialainen, *I. semicostatus* Pokhialainen, *I. peltiformis* Pokhialainen, *I. sulus* Pokhialainen, *I. terechovae* Pokhialainen, ?*I. vallejoensis* Anderson, ?*I. dunveganensis* McLearn, ?*I. scutulatus* Whitehouse, ?*I. procerus* Whitehouse	Medium to large; rounded, rounded-triangular, or oval outline; tapering dorsally, prominent narrow, pointed beaks rise slightly above hingeline and curve forwards, moderately inflated; slightly inequivalve ?; RV often with steep, shelf-like anterior margin, prominent ligamentat bearing large rounded-rectangular resilifers; almost smooth or faint, broad, concentric ribs	Essentially Upper Hauterivian; if *I. vallejoensis* is a true member, then range may extend down into the Valanginian; if *I. dunveganensis*, *I. scutulatus*, and *I. procerus* are true members, then the range may be extended up to the Upper Albian, and possibly even Middle Cenomanian	Far East of USSR, ?Antarctic Peninsula; possible extension to Japan; Pacific Coast of North America, north-east Australia
I. neocomiensis gp.	*I. neocomiensis* d'Orbigny, *I. subneocomiensis* Glazunova, *I. volgensis* Glazunova, ?*I. quatsinoensis* Whiteaves, ?*I. ewaldi* Schluter, ?*I. runcoensis* Weaver, ?*I. borealis* Glazunova, ?*I. obtusus* Glazunova, ?*I. gusselkarensis* Glazunova, ?*I. puchiahyuen* Zakharov and Turbina	Small to medium; broad, rounded-triangular outline; weakly to moderately inflated, LV slightly larger and more convex than RV; straight anterior margin; apical angle approx. 95–115°; narrow, closely and evenly spaced ribs which occasionally split or become irregular; ribs have acute to rounded summits and are sometimes superimposed on primary low folds	Barremian–Aptian, with a possible downward extension into Hauterivian and Valanginian	Europe; south-western USSR, ?Far East of USSR, Pacific Coast of North America, southern Argentina
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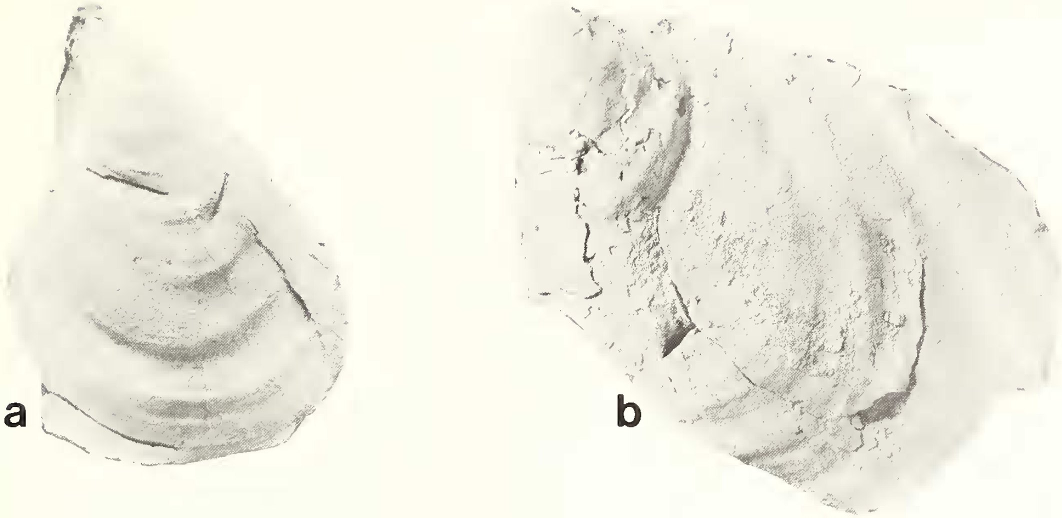
I. anglicus gp.	*I. anglicus* Woods, *I. subanglicus* Pergament, *I. anglicus elongatus* Pergament, *I. anglicus conjugalis* Pergament, ?*I. dowlingi* McLearn, ?*I. cadottensis* McLearn, ?*I. comancheanus* Cragin, ?*I. bellvuensis* Reeside	Small to very large; broad rounded to rounded-triangular outline; length approximately equal to width; anterior region more prominent and apical angle larger than in *I. neocomiensis* group; weakly inflated; slightly inequivalve ?; narrow, regular concentric ribs usually have well-rounded summits and are separated by broad, flat interspaces; ribs typically symmetrical about growth axis and occasionally weaken or bifurcate	Essentially Middle–Upper Albian, but may also range into both Lower Albian and Lower Cenomanian	Europe; south-western USSR; Far East of USSR; Japan; Pacific Coast of North America; East Greenland; eastern Mexico
I. carsoni gp.	*I. carsoni* M'Coy, *I. sutherlandi* M'Coy	Medium to very large; sub-erect to strongly obliquely elongated; both narrow and broad forms exist; equivalve to slightly inequivalve ?; moderately to strongly inflated over the umbonal region but flattened ventrally; pointed umbonal region strongly projecting; anterior margin often in the form of a shallow sigmoidal curve; narrow, regular concentric ornament which may be in two distinct phases	Upper Albian	North-east Australia

TABLE 1 (*cont.*)

Genus and group name	Component species	Diagnostic features	Stratigraphic range	Distribution
B. salomoni gp.	*I. salomoni* d'Orbigny, *I. coptensis* Casey	Small to medium; rounded-rectangular to obliquely elongated, moderately to strongly inequivalve; LV moderately inflated, RV only weakly so, LV umbo strongly incurved, broad, shallow sulcus on LV variably developed, simple, regular concentric ornament	Essentially Lower Albian, but *I. salomoni* may range into the Middle Albian	Although originally restricted to southern England, *I. coptensis* may also occur in South Africa and Angola; *I. salomoni*—Western Europe, south-western USSR, Far East of USSR, Pacific Coast of USA, ?Peru
B. concentrica gp.	*I. concentricus* Parkinson, *I. concentricus nipponicus* Nagao and Matsumoto (pars ?), *I. concentricus costatus* Nagao and Matsumoto (pars ?), ?*I. zuvolpensis* Glazunova, ?*I. volviumbonatus* Etheridge, ?*I. worakius* Wellman, ?*I. tenuis* Mantell, ?*I. corpulentus* McLearn (pars), ?*I. incelebratus* Pergament, ?*I. ordinarius* Pergament	Small to medium, occasionally large; obliquely oval to pyriform; noticeably longer than wide; short hingeline; posterior wing missing; moderately to very strongly inequivalve; LV always more strongly inflated than RV; narrow, prominent, and strongly enrolled umbo LV gives gryphaeoid appearance; thin prismatic shell layer; simple regular concentric ornament which may be traversed by weakly developed radial folds and sulci	Essentially Middle and Upper Albian, but with the possibility of a few Lower Albian records; may also extend well into the Cenomanian	Europe, south-western USSR, Far East of USSR; Pacific Coast of North America, eastern Mexico; Brazil; ?Peru, ?southern Argentina; South Africa; New Zealand, Antarctic Peninsula
B. sulcata gp	*I. sulcatus* Parkinson, *I. subsulcatus* Wiltshire, *I. sulcatoides* Saveliev, ?*I. subsulcatiformis* Böse	Similar to small *B. concentrica* but with strong radial plicae covering all or part of shell	May well be restricted to Upper Albian, but there are a few possible Middle Albian records	Europe; south-western USSR, Far East of USSR, Japan, Pacific Coast of North America; eastern Mexico; South Africa
Anopaea	*A. bruchowi* (Rouillier), *A. trapezoidalis* (Thomson and Willey), *A. constrictus* (Etheridge), ?*I. mandibulaeformis* Pokhialainen, ?*I. mandibula* Mordvilko	Small to medium; elongate-pyriform outline, with high rounded posterior and narrow, pointed anterior, deep anterodorsal lunule; variably developed anterior sulcus; long, gently sloping hingeline; equivalve to slightly inequivalve, slightly to moderately inflated, thin prismatic shell layer; ornament of low commarginal folds with superimposed secondary growth lamellae	Barremian–Albian	Eastern England; ?Far East of USSR, ?south-western USSR; Queensland; Antarctic Peninsula

TABLE 1 (*cont.*)

Genus and group name	Component species	Diagnostic features	Stratigraphic range	Distribution
B. salomoni gp.	*I. salomoni* d'Orbigny, *I. coptensis* Casey	Small to medium; rounded-rectangular to obliquely elongated; moderately to strongly inequivalve; LV moderately inflated, RV only weakly so; LV umbo strongly incurved; broad, shallow sulcus on LV variably developed; simple, regular concentric ornament	Essentially Lower Albian, but *I. salomoni* may range into the Middle Albian	Although originally restricted to southern England, *I. coptensis* may also occur in South Africa and Angola; *I. salomoni*—Western Europe, south-western USSR, Far East of USSR, Pacific Coast of USA, ?Peru
B. concentrica gp.	*I. concentricus* Parkinson, *I. concentricus nipponicus* Nagao and Matsumoto (pars ?), *I.* concentricus costatus Nagao and Matsumoto (pars ?), ?*I. zavoljiensis* Glazunova, ?*I. volviumbonatus* Etheridge, ?*I. warakius* Wellman, ?*I. tenuis* Mantell, ?*I. corpulentus* McLearn (pars), ?*I. incelebratus* Pergament, ?*I. reduncus* Pergament	Small to medium, occasionally large; obliquely oval to pyriform; noticeably longer than wide; short hingeline; posterior wing missing; moderately to very strongly inequivalve; LV always more strongly inflated than RV; narrow, prominent, and strongly enrolled umbo LV gives gryphaeoid appearance; thin prismatic shell layer; simple regular concentric ornament which may be traversed by weakly developed radial folds and sulci	Essentially Middle and Upper Albian, but with the possibility of a few Lower Albian records; may also extend well into the Cenomanian	Europe, south-western USSR; Far East of USSR; Pacific Coast of North America; eastern Mexico; Brazil; ?Peru, ?southern Argentina; South Africa; New Zealand; Antarctic Peninsula
B. sulcata gp.	*I. sulcatus* Parkinson, *I. subsulcatus* Wiltshire, *I. sulcatoides* Saveliev, ?*I. subsulcatiformis* Böse	Similar to small *B. concentrica* but with strong radial plicae covering all or part of shell	May well be restricted to Upper Albian, but there are a few possible Middle Albian records	Europe; south-western USSR; Far East of USSR; Japan; Pacific Coast of North America; eastern Mexico; South Africa
Anopaea	*A. brachowi* (Rouillier), *A. trapezoidalis* (Thomson and Willey), *A. constrictus* (Etheridge), ?*I. mandibulaformis* Pokhialainen, ?*I. mandibula* Mordvilko	Small to medium; elongate-pyriform outline, with high rounded posterior and narrow, pointed anterior; deep anterodorsal lunule; variably developed anterior sulcus; long, gently sloping hingeline; equivalve to slightly inequivalve; slightly to moderately inflated; thin prismatic shell layer; ornament of low commarginal folds with superimposed secondary growth lamellae	Berriasian–Albian	Eastern England; ?Far East of USSR; ?south-western USSR; Queensland; Antarctic Peninsula



TEXT-FIG. 4. *Inoceramus* cf. *ovatus* Stanton and *I.* sp. aff. *ellioti* Gabb from the Fossil Bluff Formation of Alexander Island. *a*, internal mould of a whole specimen of *I.* cf. *ovatus* (KG.719.15) viewed from the left side; specimen from Ablation Valley. *b*, internal mould of an incomplete left valve of *I.* sp. aff. *ellioti* (KG.401.51) from Tombaugh Cliffs. Both specimens × 1.

poorly developed primary concentric folds with a spacing of 5–7 mm. Superimposed on this initial pattern, especially in the dorsal half of the valve, are finer, closely spaced secondary ribs (text-fig. 4*a*).

The right valve has been partially crushed and its true form is uncertain. However, it probably agrees closely in size and shape with the left and it can be concluded that the specimen was, at most, only slightly inequivalve. The hinge appears to have been short and oblique and the apical angle is approximately 73°.

Remarks. The pyriform outline, narrow pointed umbones, subdued ornament, and near equality of the valves all suggest affinity with the *I. ovatus* group, and more especially with *I. ovatus* itself. However, poor preservation prevents positive identification with this species.

Inoceramus sp. aff. *ellioti* Gabb, 1869

Text-fig. 4*b*

cf. 1938 *Inoceramus ellioti* Gabb; Anderson, p. 99, pl. 7, fig. 1.
1972 *Inoceramus* sp. *a*; Thomson and Willey, p. 9, fig. 7*b*.

Holotype. Inoceramus ellioti Gabb; ?Paskenta group (Berriasian–Valanginian), Shasta series, California; refigured in Anderson (1938, pl. 7, fig. 1).

Material. One incomplete internal mould (with traces of a thin prismatic shell layer) (WS) (KG.401.51); 30 m level at Tombaugh Cliffs, Alexander Island (71° 04′ S. 68° 18′ W.; text-figs. 2 and 10).

Occurrence. As for material. Associated fossils include Berriasian ammonites, belemnites, and bivalves (Taylor *et al.* 1979, p. 36; Crame 1982, text-fig. 9). *I. ellioti* has a probable Tithonian–Valanginian age-range in California (Anderson 1938; Zakharov 1968).

Description. Although the anterior and ventral regions of this specimen are incomplete, it can be judged to have had a slightly oblique, oval outline. The better preserved left valve (text-fig. 4*b*) has an estimated length of 82 mm and a width of 59 mm (W/L = 0·72). The umbonal region is not so clearly isolated as in the specimen of *I.* cf. *ovatus* and not noticeably inclined forwards either. It merges ventrally with the moderately inflated central region of the valve and there are gentle descents to the posterior and posterodorsal margins. The latter is noticeably flatter and more pronounced than in the previous species.

Both valves bear the impressions of two phases of concentric ornament. The larger ribs have widths of 3–5 mm and low, rounded profiles. Regularly spaced and symmetrically curving over the central part of the valve, they sweep strongly forwards in the posterodorsal region. Finer secondary ribs (up to 2 mm in width) are superimposed on the primary ornament (text-fig. 4*b*).

Remarks. Even though there are similarities between this and the previous species (*I.* cf. *ovatus*) in style of ornament (see Thomson and Willey 1972, p. 9), it is apparent that there are significant differences in their respective shell forms. This specimen, with its more prominent posterodorsal region, is closer to broad forms in the *I. ovatus* group such as *I. quatsinoensis* and *I. ellioti* (Table 1). It is judged to be marginally closer to the latter, although poor preservation means that it can be only tentatively assigned to it.

Inoceramus heteropterus group

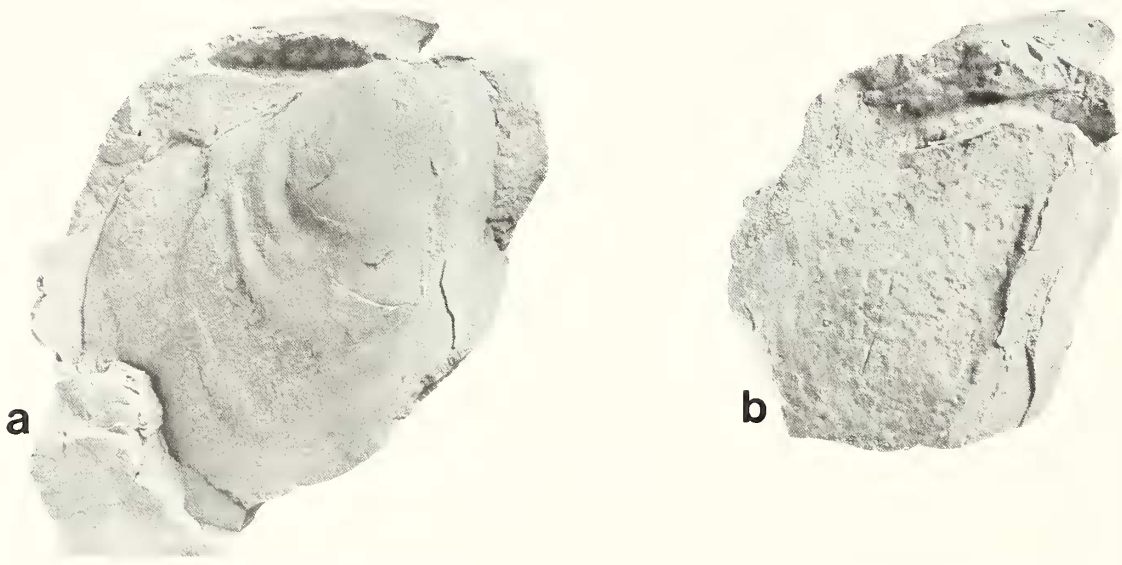
Inoceramus cf. heteropterus Pokhialainen, 1969

Text-fig. 5*a*, *b*

cf. 1969 *Inoceramus heteropterus* Pokhialainen, p. 141, pl. 14, figs. 2–4; pl. 17, fig. 4; pl. 20, fig. 3; pl. 21, fig. 4.

Holotype. *Inoceramus heteropterus* Pokhialainen (1969, p. 141, pl. 14, fig. 4; pl. 17, fig. 4); specimen No. 46a/3, Museum of the NE Complex Scientific Research Institute, Magadan; Upper Hauterivian, basin of the River Veseloy, NW Kamchatka; by original designation.

Material. Five incomplete internal moulds of whole specimens bearing traces of shell material (M.1196.3*a*–*e*); approximately the 715 m level in the Lower Tuff Member, Annenkov Island (54° 29′ S., 37° 03′ W.; text-fig. 1) (Pettigrew 1981, fig. 5; Crame 1983*a*, figs. 6 and 7).



TEXT-FIG. 5. *Inoceramus* cf. *heteropterus* Pokhialainen from Annenkov Island. *a*, internal mould (with traces of a thick prismatic shell layer) of an incomplete whole specimen (M.1196.3*c*) viewed from the right side. *b*, internal mould (with traces of a thick prismatic shell layer) of an incomplete whole specimen (M.1196.3*d*) viewed from the right. Both specimens ×1.

Occurrence. As for material. The *I. heteropterus* group is Upper Hauterivian in the Far East of USSR (Table 1), but this age may have to be extended down to at least the Valanginian if *I. vallejoensis* Anderson is a true member of the group. Similarly, if certain younger species are subsequently referred to it, it may have to be extended to the Albian or even Cenomanian (Table 1). The Annenkov Island Formation (which includes the lower Tuff Member) is imprecisely dated in the interval Neocomian–Aptian (Thomson *et al.* 1982).

Description. The specimens are conspicuous for their oval outlines, very reduced ornament, and narrow, pointed umbones. The latter project strongly above the hinge and forwards, but are not significantly curved inwards (text-fig. 5*a*, *b*). The mean shell length of the five specimens is 84·8 mm (S.D. = 17·95; range = 71–113) and mean width is 62·4 mm (S.D. = 15·27; range = 49–86). There is some evidence that the left valves may be slightly longer than the right valves but the specimens are not well enough preserved for this to be accurately determined.

The best preserved right valve is that of specimen M.1196.3*c* (text-fig. 5*a*). It is moderately convex, with the maximum inflation occurring in the umbonal region and along the growth axis. There is a gentle gradient from the centre of the valve to the ventral region and also to the posterodorsal region where there is an indistinctly recessed wing. There is a significantly steeper descent from the anterior margin of the valve to the plane of commissure. This occurs across a flat to gently concave shelf up to 13 mm wide (text-fig. 5*a*). At its dorsal end, directly beneath the umbo, the shelf assumes a more strongly concave profile and could be described as a gutter. Its presence is related to the curve of the umbo up and away from the hinge margin. The beak is missing, but by comparison with specimens M.1196.3*b* and *d*, it can be judged to have been narrow, pointed, and prosogyrous. A similar, but slightly shallower, concave gutter separates it from the hinge margin.

The left valves are not so well preserved as the right valves. In outline and general form they appear to be close to the latter and there are some indications that they may be marginally narrower and more evenly inflated. Specimen M.1196.3*d* has a very pronounced anterior shelf which again runs steeply from the anterior margin to the plane of commissure and has an approximate width of 15 mm. The net effect of the very pronounced anterior shelf on both valves must have been to produce a projection with a distinctly 'V' shaped cross-section.

The anterior shelf of the left valve also narrows and deepens directly beneath the umbo (text-fig. 5*a*, *b*). The separation of the left umbo from the hingeline is best seen from the right side where a smooth, narrow, triangular area can be clearly distinguished between the beak and the dorsal surface of the ligamentat (text-fig. 5*a*, *b*). The latter feature, which is the surface on which the ligament pits are arranged (Pokhialainen 1969), is partially displayed on specimens M.1196.3*b*–*d*; on M.1196.3*c* it has an approximate length of 30 mm and a depth of 5 mm in the centre. There is some evidence that it may have had a convex upper (dorsal) surface but this could not be definitely confirmed. The largest ligament pits certainly seem to be in the centre of the ligamentat where they are preserved as a rather irregular row of barrel-like proturberances with convex sides (text-fig. 5*a*). Much of the surface detail of the pits has been lost and it is uncertain whether they are simple or composed of composite elements.

On both valves there are faint traces of broad, low concentric folds.

Remarks. These almost smooth, oval shells with prominent, pointed umbones can be readily linked to the *I. heteropterus* group from the Soviet Far East. Unfortunately, this group is almost exclusively known from a single taxonomic study (Pokhialainen 1969) and the relationships between the component species are not always clear. The Annenkov Island specimens are judged to be closest to *I. heteropterus* itself, which exhibits a very similar range of shell sizes and morphologies (cf. Pokhialainen 1969, pl. 14, figs. 2 and 3; pl. 17, fig. 4; pl. 20, fig. 3; pl. 21, fig. 4). In particular, this species has a steeply descending anterior margin on the right valve which assumes a deep concave profile at its dorsal end, as well as a conspicuous ligamentat bearing large rounded-rectangular ligament pits (Pokhialainen 1969, pl. 15, fig. 6; pl. 20, fig. 3). As the specimens may be slightly less inequivalve than the Russian material, and have more prominent left anterior margins, they are only tentatively referred to *I. heteropterus*.

I. solus Pokhialainen (1969, pl. 13, fig. 6; pl. 20, fig. 7) is very close to *I. heteropterus* but can be distinguished by a slightly larger apical angle, distinctive ligamentat, and less prominent hollow (gutter) on the anterior margin. *I. peltiformis* Pokhialainen (1969, pl. 12, fig. 2; pl. 13, figs. 1-5) is a rounder and more convex form with traces of a distinct posterodorsal wing. The same feature is also present on *I. semicostatus* Pokhialainen (1969, pl. 14, fig. 1; pl. 17, figs. 1-3) which is an elongate-rounded form with prominent concentric ornament present on the smaller (?juvenile) specimens. It too, has a distinctive ligamentat and lacks a deep concave hollow along the anterodorsal margin.

Inoceramus neocomiensis group
Inoceramus deltoides sp. nov.

Plate 54, figs. 1-7; Plate 55, figs. 1, 2

Type material. Holotype: KG.1678.7 (RV?). Paratypes: KG.1677.2-4; KG.1678.5-7, 9; KG.1701.33, 34; KG.1730.13-16, 18, 20-22, 24; KG.1735.4-9, 13-24, 26-30, 32-37; KG.1743.1-7, 9; KG.1745.15; KG.2800.9, 31, 33, 84-86, 88, 264, 281, 282, 343, 344, 347, 348, 1113-1121, 1127-1130, 1133, 1136-1139 (both int.m. + ext. m.; RV's, LV's + indet. V's). From the following localities (see text-fig. 2): KG.1677—ridge between Mt. Lassell and Mt. Phoebe (71° 45′ 30″ S., 68° 49′ W.); KG.1678/1730—N face of Mt. Lassell, Neptune Glacier (71° 43′ S., 68° 45′ W.); KG.1701—Citadel Bastion (71° 59′ S., 68° 32′ W.) (probably loose); KG.1735—nunatak 0·6 km W of Mt. Lassell (71° 43′ 30″ S., 68° 52′ W.); KG.1743/2800—Fossil Bluff (71° 19′ S., 68° 17′ W.); KG.1745—locality U—2 km NW of Fossil Bluff (71° 18′ S., 68° 20′ W.). At locality KG.1743/2800 the specimens occur between 96 and 133 m in a 426 m section (text-fig. 10); their occurrence at localities to the south of Fossil Bluff (text-fig. 2) is due to tectonic repetition of the Fossil Bluff Formation.

Occurrence. As for the type material. Associated aconeceratid and heteromorph ammonites strongly suggest an Aptian age, although there is a possibility that some of them may have Barremian affinities too (Thomson 1974, 1983). Co-occurring specimens belonging to the *Aucellina andina-radiatostriata* group suggest an Aptian-Albian age (Crame 1983*a*).

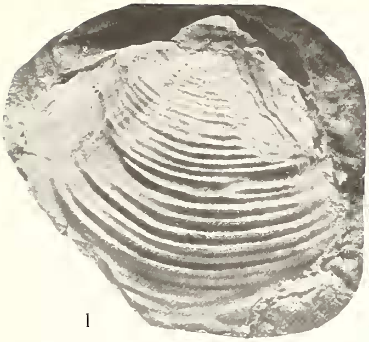
Derivation of name. From the distinctive delta-like, or triangular, outline.

Diagnosis. Medium to large, weakly inflated *Inoceramus* with a triangular outline; ornament of narrow, regularly spaced concentric ribs that are slightly asymmetric about the growth axis; ornament lacking in the ventral regions of the largest specimens; slightly inequivalve.

Description. First impressions of this species are those of a medium-sized, flat triangular shell that varies from roughly equilateral in outline (e.g. KG.1678.6 and 7; Pl. 54, fig. 1 and Pl. 55, fig. 2) to slightly oblique and inequilateral (e.g. KG.1677.4 and 1735.9; Pl. 54, figs. 4 and 6). Although it is often difficult to distinguish between right and left valves, it is apparent that, in all the asymmetric specimens, it is the anterior region which becomes reduced; the extent of this reduction varies from barely detectable to the pronounced state seen in two of the three articulated specimens (e.g. KG.1745.15; Pl. 54, fig. 2). The latter specimens are also of interest in that their left valves are slightly larger and have more inflated umbonal regions than the right valves. There is also a general impression from study of the single valves that at least some of the left valves have more inflated umbones than the right valves (e.g. KG.1677.4; Pl. 54, fig. 6).

EXPLANATION OF PLATE 54

Figs. 1-7. *Inoceramus deltoides* sp. nov. from the Fossil Bluff Formation of Alexander Island. 1, internal mould of probable right valve (KG.1678.6); Mt. Lassell. 2, internal mould of small whole specimen (KG.1745.15) viewed from the right side; locality U near Fossil Bluff. 3, rubber peel from the external mould of indeterminate valve (KG.2800.1128); Fossil Bluff. 4, internal mould of probable left valve (KG.1735.9); nunatak 0·6 km due W of Mt. Lassell. 5, rubber peel from external mould of probable right valve (KG.1678.9); Mt. Lassell. 6, internal mould of left valve (KG.1677.4); Mt. Lassell-Mt. Phoebe ridge. 7, rubber peel from external mould of probable right valve (KG.1678.5); Mt. Lassell. All specimens × 1, except for fig. 2 which is × 1·5.



1

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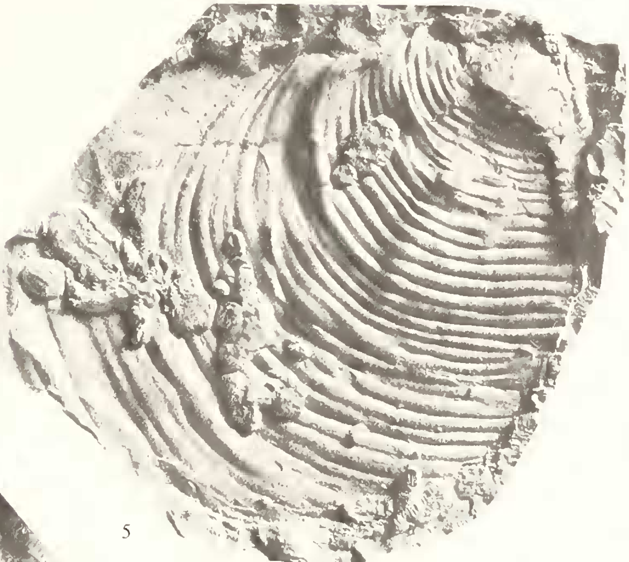

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CRAME, *Inoceramus* from Antarctica

Owing to the uncertainty of the orientation (i.e. left or right) of many valves the following measurements are based on an undifferentiated sample. It should be borne in mind that the left valves may be very slightly longer than the right valves, and also that, owing to the poor state of preservation, most specimens are probably incomplete. The mean estimated shell length is 69·11 mm (S.D. = 22·65; range = 41–175; N = 44), mean width is 62·30 mm (S.D. = 31·48; range = 32–210; N = 44), and mean ratio of width to length is 0·89 (S.D. = 0·23; range = 0·62–1.55; N = 44). Thus, the average shell shape is roughly that of an isosceles triangle that is marginally taller than it is broad (e.g. KG.1678.7; Pl. 55, fig. 2); common variants are narrower, oblique types (e.g. KG.1677.4; Pl. 54, fig. 6) and squatter, broader forms with expanded ventral regions (e.g. KG.1735.14*a*; Pl. 55, fig. 1). Where preserved the anterior and posterior margins appear to be essentially straight features that enclose an apical angle that approximates to a right angle ($\bar{x} = 91·16°$; S.D. = 14·69; range = 73°–132°; N = 45) (e.g. KG.1678.6, 7, 1735.9, and 2800.1128; Pl. 54, figs. 1, 3, 4 and Pl. 55, fig. 2). In those valves with attenuated anterior regions, a short, straight anterodorsal margin passes into a gently to strongly convex anteroventral margin (e.g. KG.1677.4; Pl. 54, fig. 6). The ventral margin always appears to be well rounded.

The valves are weakly to moderately inflated with the maximum inflation occurring in the umbonal region. As well as the single left valves with more inflated umbones (e.g. KG.1677.4), there are some large right valves in which the umbones rise steeply from a weakly inflated valve surface (e.g. KG.1677.2 and 3). A distinctive feature of this species is its narrow, regularly spaced concentric ornament. This is best seen in the early stages of the shell where the ribs are typically 1–1·5 mm in width, have acute to rounded profiles, and are separated by narrow interspaces (e.g. KG.1678.7, 1735.9, 2800.1128; Pl. 54, figs. 3, 4; Pl. 55, fig. 2). Usually arranged slightly asymmetrically about the growth axis, they occasionally anastomose or die out (e.g. KG.1678.6, 1735.14*a*, 2800.1128; Pl. 54, figs. 1, 3; Pl. 55, fig. 1); for the most part, however, they are remarkably uniform in their size and distribution. On some of the larger specimens there is a tendency for the ribs to become coarser and irregular in the posteroventral and ventral regions. Here they are bunched into thicker features 4–5 mm in width, which, when traced into the posterodorsal region, sweep strongly forwards and diminish in intensity (e.g. KG.1678.5 and 9; Pl. 54, figs. 5 and 7). On the largest specimens the concentric ribs can be up to 2 mm in width and are separated by shallow, flat-floored interspaces of similar, or even slightly greater, size. They are essentially restricted to the umbonal and central regions of the valve and, when traced towards the anterior, posterior, and ventral margins, are seen to die out rapidly (e.g. KG.1677.2, 3 and 1735.8). They are replaced by areas of smooth, undulatory shell and it can be concluded that this dimorphic ornament pattern is a consistent feature of all the largest valves. A final characteristic to be noted about the ornament is the tendency for the fine concentric ribs of some specimens to be grouped (and slightly raised) on low primary folds. This is best seen in the umbonal region of the largest specimen (KG.1677.3) but can also be detected on a number of smaller valves. This style of ornament is close to Heinz's (1928*a*) *Anwachsringreifen*.

Those specimens with the most strongly reduced anterior regions show obvious similarities in outline to *Anopaea* (e.g. KG.1745.15; Pl. 54, fig. 2); these are enhanced by the presence on some valves of a very shallow anteroventral sulcus (e.g. KG.1735.4). Such material can be taken as further evidence of possible morphological transitions between *Inoceramus* and *Anopaea*.

Remarks. The flat, triangular form and regular, closely spaced concentric ornament readily link *I. deltoides* sp. nov. with either the *I. neocomiensis* or *I. anglicus* groups. Features which suggest a greater affinity to the former of these include: a mean apical angle in the region of 90°, the absence of a protruding anterior region, the slightly inequivalve nature of the shell (with the left valve being the more convex), comparatively narrow ornament with acute to rounded summits, and the occasional presence of *Anwachsringreifen* (Table 1). There are in fact considerable similarities, especially in style of ornament, with *I. neocomiensis* itself, although this species is usually interpreted as a comparatively small and more strongly inequivalve form (e.g. d'Orbigny 1846, pl. 403, figs. 1 and 2; Woods 1911, pl. 45, figs. 1 and 2; Glazunova 1973, pl. 19, fig. 1*a*, *b*). *I. subneocomiensis* reaches larger sizes (> 100 mm in length) and shows a distinct tendency to develop *Anwachsringreifen* (e.g. Glazunova 1973, pl. 16, fig. 4 and pl. 17, fig. 1); however, on the early stages of the valve the ribbing is less distinct than on *I. deltoides* sp. nov. and on some of the smaller specimens it is noticeably less regular (e.g. Glazunova 1973, pl. 17, fig. 2). Much clearer regular ornament is seen on both *I. borealis* and *I. obtusus* from the Russian Platform (Glazunova 1973, pl. 13, figs. 1–3; pl. 14, figs. 1 and 2; pl. 15, figs. 1–3; pl. 16, figs. 1 and 2), but in both these species the interspace width exceeds that of the ribs and the overall ornament style is closer to that of *I. anglicus* than *I. neocomiensis*. Large specimens of *I. cadottensis* McLearn from the Albian of the Canadian west coast and Alaska also show a pronounced change from narrow, regularly spaced ribs over the central regions of the valve to almost smooth ventral and posterior margins (e.g. Imlay 1961, pl. 9, fig. 1; Jeletzky 1964, pl. 27, fig. 7). However, it is apparent that this species typically has a longer hinge and more rounded-rectangular form than *I. deltoides* sp. nov. The early ribbing is also more typical of the *I. anglicus* group.

Inoceramus liwerowskyae group
Inoceramus stoneleyi sp. nov.

Plate 55, figs. 3–12

Type material. Holotype: D.8212.135 (int.m. WS with traces of outer shell layer). Paratypes: D.8210.25 (ext.m., WS); D.8210.50, 8212.103 (both int.m., LV); D.8212.180, 181 (both ext.m., LV); D.8212.101, 104, 136, 138, 139, 141–144, 182, 212, 213, 228 (all int.m., RV); D.8212.73, 140, 177 (all int.m., indet. V). Locality D.8210—N flank of pale ridge 1 km NE of Stoneley Point (63° 51′ 40″ S., 58° 06′ 20″W.); D.8212—floor of valley to S of pale ridge (63° 51′ 40″ S., 58° 05′ 20″ W.) (text-fig. 3). These localities occur between 600 and 925 m in the combined stratigraphic section measured on NW James Ross Island (text-fig. 11).

Occurrence. As for the type material. Aptian–Albian, with a possible downward extension into the Barremian (Crame 1983*a*, *b*).

Some of the poorly preserved inoceramids recorded from the Crabeater Point region on the east coast of the Antarctic Peninsula (text-fig. 1) (Thomson 1967) may also belong within this species. In particular, a series of internal moulds bearing traces of thin, blade-like concentric ribs (BMNH specimens LL16068 and 16069) closely resemble the smaller and smoother forms of *I. stoneleyi* sp. nov. (cf. Pl. 55, fig. 9; Pl. 55, figs. 6, 7, 10, 12).

Derivation of name. In recognition of the pioneer geological work in the area by Professor R. Stoneley.

Diagnosis. A small, erect *Inoceramus*; moderately inflated in the central regions but with noticeably flattened and extended valve margins; ornament weak and irregular in the centre of each valve and almost absent on the margins; equivalve.

Description. This species is judged to have been equivalve, or very nearly so. The mean estimated shell length is 25·43 mm (S.D. = 6·02; range = 15–37; N = 14) and mean shell width is 16·86 mm (S.D. = 4·47; range = 10–25; N = 14); (N.B. these measurements exclude two very small right valves (D.8212.101 and 228) with lengths of 10 and 12 mm and widths of 6 and 7 mm, respectively; these are almost certainly juveniles). The right valve of the holotype has an erect, oval outline which is slightly accentuated by the missing tip of the umbo (Pl. 55, fig. 5). However, this feature is present on other right valves and is clearly narrow and turned weakly forwards (e.g. D.8212.104; Pl. 55, fig. 7). It is apparent that the apical region is always considerably narrower than the ventral and that the valves are more asymmetric about an imaginary midline than the first impression gained by cursory examination of the holotype. The maximum degree of inflation occurs in the centre of the valve and usually follows the growth axis from the beak to a point close to the ventral margin. On the anterior, ventral, and posterior margins there is an abrupt flattening to form a distinct rim (or shelf) between 4 and 6 mm in width; the junction between the main part of the valve and this rim is marked by a shallow depression (Pl. 55, figs. 3 and 5). Apparently restricted to just the largest specimens, there are some indications that this rim may diminish in the anterodorsal region where there is usually the steepest descent from the centre of the valve to the margin. On some specimens, such as D.8212.212 (which is a small, flattened right valve), there appears to have been a steep descent along the greater part of the anterior margin (Pl. 55, fig. 8), and thus the rim may have been essentially restricted to the ventral and posterior regions.

The ornament on the right valve of the holotype, which is preserved in prismatic shell material, consists of narrow (< 1 mm wide) concentric ribs that are slightly asymmetric about the growth axis (Pl. 55, fig. 5). Their spacing is close but by no means regular, and, when traced towards the valve margins, they show some tendency to anastomose or disappear. In any event, all the ornament disappears at the annular depression and the marginal rim is smooth (Pl. 55, figs. 3 and 5). The style of ornament over the central region of the valve is characteristic of all the right valves in the collection, although there is some variation in intensity of ribbing (Pl. 55, figs. 5, 7, 8, 10–12). On specimen D.8212.212, ribs of up to 2 mm in width are preserved in thick shell material in the posterodorsal region; here they are closely intercalated with narrower, discontinuous ribs (Pl. 55, fig. 8). Along the dorsal margin of this specimen the same thick shell layer has preserved a ligamentat measuring approximately 19 mm in length and 4·5 mm in height. This feature, which is set at an angle to the plane of commissure, bears the remnants of three large and four small, intercalated, ligament pits. The larger types have rectangular flask-shaped profiles, tapering gradually from the ventral to dorsal margins of the ligamentat, whilst the smaller, narrower ones taper correspondingly in the opposite direction. A large, oval, posterior adductor muscle scar is visible in the posterodorsal quadrant of the holotype's right valve (Pl. 55, fig. 5).

Although less well preserved, the left valve of the holotype appears to be essentially similar in form and style of ornament to the right. Left valves as a whole are less well represented in the collection but those that are present suggest that they exhibit a range of variation very similar to that seen in the rights (D.8210.50, 8212.103, 135; Pl. 55, figs. 3, 4, 6).

Remarks. Originally thought to be a small member of the *I. neocomiensis* group (Crame 1983*a*, *b*) it is now apparent that this species is better classified within the *I. liwerowskyae* group (Table 1). Perhaps its closest resemblance is with *I. spitzbergensis* Stolley (1912, p. 20 and pl. 1, figs. 5 and 6) from the Aptian/Albian of Spitzbergen. This species too, is small and erect, and shows a similar transition from a well-inflated central region to much flatter margins. It has narrow, closely spaced concentric ribs which occasionally become larger, irregular in their course and wedge-shaped in cross-section. Nevertheless, despite these similarities, it would appear that *I. spitzbergensis* has a more quadrate outline, due principally to the presence of a right-angled posterodorsal wing, and there is also the possibility that it has a more angular ventral margin (Stolley 1912, pl. 1, fig. 5). The narrower form of *I. liwerowskyae* Saveliev (1962, p. 228 and pl. 5, figs. 2–8) from the Upper Albian of Mangishlak is close to specimens such as D.8212.104 and 141 which lack an outer rim (Pl. 55, figs. 7 and 12), although it would seem that this species has consistently finer and closer spaced ornament. It also has slightly more pointed umbones and there is some tendency towards the formation of a small posterodorsal wing (e.g. Saveliev 1962, pl. 5, fig. 2). Both *I. kedroviensis* Pergament (1965, p. 28 and pl. 9, figs. 3 and 4) from the Albian of north-west Kamchatka and *I. saratoviensis* Glazunova (1973, p. 46, pl. 21, figs. 3 and 4) from the late Aptian of the Russian Platform could be matched with some of the

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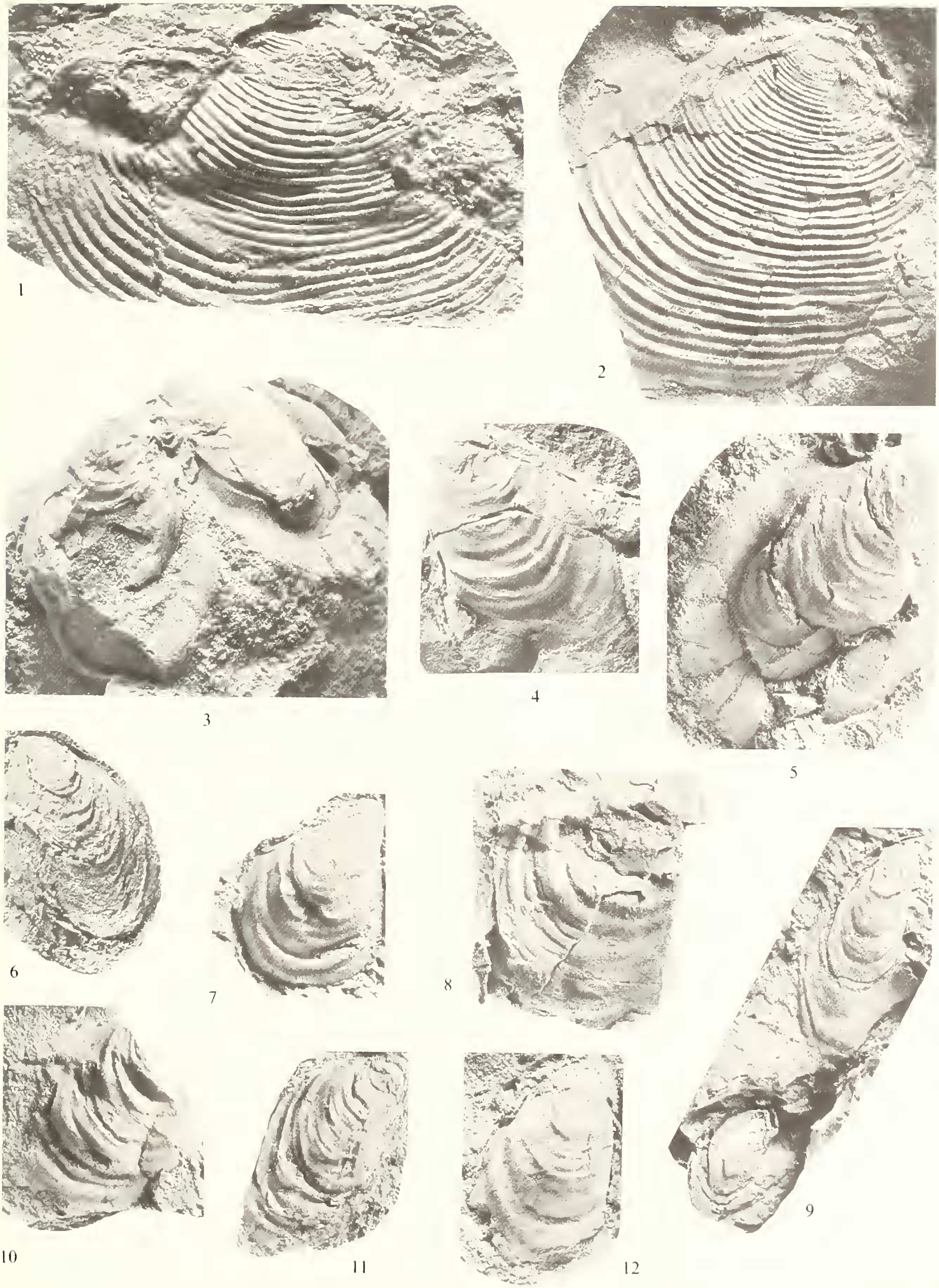
EXPLANATION OF PLATE 55

Figs. 1 and 2. *Inoceramus deltoides* sp. nov. from the Fossil Bluff Formation of Alexander Island. 1, rubber peel from an external mould of an indeterminate valve (KG.1735.14*a*); small nunatak 0·6 km due W of Mt. Lassell. 2, holotype (KG.1678.7), an internal mould of a probable right valve; Mt. Lassell. Both specimens × 1.

Figs. 3–8, 10–12. *Inoceramus stoneleyi* sp. nov. from the Stoneley Point region, NW James Ross Island. 3, posterodorsal view of holotype (D.8212.135); the specimen, which is an internal mould bearing traces of a prismatic shell layer, is joined at the hinge but gapes widely ventrally. 4, internal mould of left valve (D.8212.103). 5, right valve of holotype. 6, internal mould of left valve (D.8210.50). 7, internal mould of right valve (D.8212.104). 8, internal mould of right valve (D.8212.212) partly covered by a thick prismatic shell layer. 10, internal mould of incomplete right valve (D.8212.138). 11, internal mould of right valve (D.8212.144). 12, internal mould of right valve (D.8212.141). All specimens × 1·5.

Fig. 9. Possible specimens of *I. stoneleyi* sp. nov. (BMNH LL.16068) from Crabeater Point, Kenyon Peninsula. Both specimens are internal moulds of right valves. × 1·5.



CRAME, *Inoceramus* from Antarctica

smoother forms of *I. stoneleyi* sp. nov. (e.g. Pl. 55, figs. 7, 10, 12). However, there is some evidence to suggest that the former of these Russian species is narrower and closer in outline to *I. liwerowskyae*, whilst the latter has a much more rounded-triangular outline.

Inoceramus flemingi sp. nov.

Plate 56, figs. 1, 2

Type material. Holotype: KG.1726.10 (int.m., LV). Paratypes: KG.1726.2, 3, 14 (all int.m., LV); KG.1726.7 (ext.m., LV); KG.1726.5, 8 (both int.m., RV); ?KG.1682.36 (int.m., RV). Locality KG.1726 is on the ridge running SSW from Mt. Phoebe (71° 48′ 30″ S., 68° 48′ 00″ W.) and KG.1682 is at a high level in Waitabit Cliffs, Alexander Island (71° 30′ S., 68° 48′ W.; text-fig. 2). At both these localities the specimens occur in close association with *Birostrina*? cf. *concentrica*.

Occurrence. Albian (probably Middle–Upper Albian), from its close association with *B.*? cf. *concentrica* at both localities KG.1682 and 1726.

Derivation of name. In honour of the Rt. Revd. W. L. S. Fleming, geologist on the British Graham Land Expedition (1934–1937) and the first person to collect fossils from Alexander Island.

Diagnosis. A small, erect *Inoceramus* with prominent concentric ornament, slightly prosogyrous umbones, and a flange-like posterodorsal wing; prominent ligamentat bearing flask-shaped ligament pits; equivalve, or very nearly so.

Description. This is a small species with a mean shell length of 27·38 mm (S.D. = 7·96; range = 18–38; N = 8) and a mean width of 17·13 mm (S.D. = 5·64; range = 11–27; N = 8). Both valves have erect, rounded-quadrate outlines and prosogyrous umbones that terminate in narrow, pointed beaks (Pl. 56, figs. 1 and 3). The latter reach up to the level of the long, straight hingeline which subtends a mean apical angle of 75·88° (S.D. = 6·56; range = 68°–84°; N = 8) with the straight to gently convex anterior margin. The ventral margin is well rounded but the posterior is much less steeply convex and in some specimens comes to lie subparallel to the anterior. On the holotype a prominent ligamentat is displayed (Pl. 56, fig. 1), which, when complete, would have had dimensions of approximately 14 × 2 mm. The prominent ligament pits are distinctly flask-shaped, with well-rounded, bulbous bases tapering up into narrow necks.

Both valves are moderately inflated, with the maximum degree of inflation occurring along the growth axis. There are even descents from the apex of convexity to all the margins and in the posterodorsal region there is a narrow, indistinctly recessed wing. This is best seen on the holotype where it forms a smooth flange-like feature up to 6 mm in width (Pl. 56, fig. 1). The ornament consists of a simple pattern of clearly defined and regularly spaced concentric ribs that are symmetrically arranged about the growth axis (e.g. KG.1726.8, 10; Pl. 56, figs. 1 and 3); in cross-section these ribs

EXPLANATION OF PLATE 56

Figs. 1 and 3. *Inoceramus flemingi* sp. nov. from the Fossil Bluff Formation of Alexander Island. 1, holotype, an internal mould of a left valve (KG.1726.10) from the ridge running SSW from Mt. Phoebe. 3, internal mould of right valve (KG.1726.8) from the same locality. Both specimens × 1·5.

Fig. 2. *Inoceramus urius* Wellman. Plaster cast of the holotype (a left valve, NZGS TM2116) from the Upper Albian Motuan stage of New Zealand. × 1.

Figs. 4, 5, and 7. *Inoceramus* cf. *anglicus elongatus* Pergament from the Fossil Bluff Formation of Alexander Island. 4, internal mould of left valve (KG.1680.72); Keystone Cliffs. 5, internal mould of left valve (KG.1680.2); same locality. 7, internal mould of left valve (KG.106.3); same locality. All specimens × 1.

Figs. 6 and 8. *Inoceramus* sp. aff. *comancheanus* Cragin from the Fossil Bluff Formation of Alexander Island. 6, internal mould of right valve (KG.1606.18); Hyperion Nunataks. 8, internal mould of left valve (KG.1680.73); Keystone Cliffs. Both specimens × 1.

Fig. 9. *Inoceramus* sp. aff. *anglicus* Woods. Rubber peel from an external mould of a large, incomplete right valve (BR.151.12); Welchness, western Dundee Island. × 1.

CRAME, *Inoceramus* from Antarctica

typically have an acute profile, tapering from a broad base to a summit no more than 0·5 mm in width. On most specimens the interspace width increases from approximately 0·5 mm over the umbo to 2·0–2·5 mm close to the ventral margin. Although there may be some difference in the size of the posterodorsal wing between the left and right valves, they are in all other aspects very similar.

Remarks. This small, erect, equivalve (or nearly so) species probably has its closest links with the *I. liwerowskyae* group (Table 1). However, it should be noted that the ornament seems to be consistently stronger and more regular than almost all members of this group, with the possible exception of *I. liwerowskyae* itself from the Upper Albian of Mangishlak. The holotype of this species does bear moderately strong, regular concentric ribs (cf. Saveliev 1962, pl. 5, fig. 6; Pl. 56, fig. 1) but all Saveliev's (1962, pl. 5, figs. 2–5, 7, 8) other illustrated material is characterized by much finer ribbing. The prominent ligamentat suggests a possible link with *I. urius* Wellman from the Upper Albian of New Zealand (see Pl. 56, fig. 2), but this species has a slightly different outline and much less uniform ornament. Although *I. flemingi* sp. nov. is similar in size to *I. stoneleyi* sp. nov. and some specimens possess a flattened posterodorsal area, it can be readily distinguished by its prominent ligamentat and strong, regular ornament.

Inoceramus anglicus group

Inoceramus sp. aff. *anglicus* Woods, 1911

Plate 56, fig. 9

cf. 1911 *Inoceramus anglicus* Woods, p. 264, text-fig. 29.
cf. 1961 *Inoceramus anglicus* Woods; Imlay, p. 52, pl. 9, figs. 4 and 6; pl. 10, fig. 9.
cf. 1965 *Inoceramus* cf. *anglicus* Woods; Pergament, pl. 3, fig. 2.
cf. 1965 *Inoceramus* sp. aff. *anglicus* Woods; Pergament, pl. 6, fig. 4.
cf. 1973 *Inoceramus anglicus* Woods; Glazunova, p. 49, pl. 19, fig. 4; pl. 21, figs. 1 and 2.

Lectotype. Inoceramus anglicus Woods (1911, pl. 45, fig. 8*a*, *b*), Red Limestone (Albian), Hunstanton; designated by Saveliev (1962, p. 223).

Material. Two large fragments (with traces of shell material): BR.151.12 (ext.m., RV); BR.151.11 (int.m., LV). From the large lateral moraine at Welchness, western Dundee Island (63° 29′ S., 56° 15′ W.) (text-fig. 1).

Occurrence. I. anglicus is Middle–Upper Albian, with possible extensions into both the Lower Albian and Lower Cenomanian (Table 1). The predominantly Middle–Upper Albian species, *B. concentrica*, has also been recorded from Dundee Island (Crame 1980).

Description and remarks. Whereas specimen BR.151.12 had an original shell length of approximately 160 mm and a width of 100 mm, specimen BR.151.11 appears to have been significantly smaller, with corresponding dimensions of approximately 105 and 75 mm. All the valve margins are incomplete, but it can be judged, from the course of the ornament, that the form was sub-erect to erect. Both specimens are only weakly inflated. The most characteristic feature of this material is its strong, regular, and widely spaced concentric ornament; the component ribs, which are 1–2 mm in width and have well-rounded cross-profiles, are separated by broad, flat interspaces that vary from 2–3 mm in width on the early part of the shell to up to 7 mm towards the ventral margin (e.g. BR.151.12; Pl. 56, fig. 9). This style of ornament is reminiscent of that found on both large specimens of *I. anglicus typica* (e.g. Woods 1911, text-fig. 29; Imlay 1961, pl. 9, figs. 4 and 6, pl. 10, fig. 9; Glazunova 1973, pl. 19, fig. 4, pl. 21, figs 1 and 2) and large fragments tentatively assigned to the *I. anglicus* group (e.g. Pergament 1965, pl. 3, fig. 2, pl. 6, fig. 4).

Inoceramus cf. *anglicus elongatus* Pergament, 1965

Plate 56, figs. 4, 5, 7

cf. 1965 *Inoceramus anglicus elongatus* Pergament, p. 19, pl. 2, figs. 3 and 4; pl. 6, fig. 3.
1972 *Inoceramus* sp. β; Thomson and Willey, p. 11 and fig. 7*d*.

Holotype. Inoceramus anglicus elongatus Pergament; specimen 3/70*a* from the Albian of the River Kedrovoy region, Kamchatka (Pergament 1965, p. 19, pl. 2, fig. 3); by original designation.

Material. KG.106.3, 1680.2, 3, 30, 72, 75 (all int.m., LV); KG.1680.59 (ext.m., RV); RV.1680.5 (ext.m., ?RV); KG.1663.33, 1680.4 (both int.m., ?RV); KG.1681.5. (ext.m., indet.V). Localities KG.106 and 1680 are in the lowest 32 m of the section at Keystone Cliffs (71° 33′ 00″ S., 68° 15′ 30″ W.) and KG.1681 is from an equivalent stratigraphic level at the top of Waitabit Cliffs (71° 30′ 00″ S., 68° 14′ 30″ W.). Locality KG.1663 is on the W side of Stephenson Nunatak (72° 08′ 30″ S., 69° 09′ 00″ W.; text-figs. 2 and 10).

Occurrence. On balance the upper levels of Waitabit Cliffs and lower levels of Keystone Cliffs have an Albian age (Taylor *et al.* 1979); however, a few ammonites from these localities have older affinities (Thomson 1974, 1983) and their presence has yet to be fully explained. *I. anglicus elongatus* is Middle–Upper Albian in Kamchatka (Pergament 1965, fig. 6) and in England specimens provisionally identified as *I.* cf. *anglicus elongatus* occur in the lower Cenomanian (Kauffman 1978*b*, p. IV.5).

Description. This is a small to medium-sized species with an erect to slightly obliquely elongated outline; the mean shell length is 46·36 mm (S.D. = 9·00; range = 36–63; N = 11) and mean width is 30·73 mm (S.D. = 5·95; range = 22–40; N = 11). At first sight, it would appear to be significantly narrower than the similarly ribbed *I. deltoides* sp. nov. (cf. Pl. 54, figs. 1–7; Pl. 56, figs. 5–7), but, when the respective mean apical angles (cf. *anglicus elongatus* = 82·3°: *deltoides* sp. nov. = 91·16°) are compared, they are not found to be significantly different (Student's *t*-test, $p > 0·05$). This is largely due to the presence of a prominent hinge region on some specimens of *I.* cf. *anglicus elongatus* which rises well above the posterodorsal margin of the valve (e.g. KG.106.3 and 1680.2; Pl. 56, figs. 5 and 7). There is no evidence of a corresponding feature of similar magnitude on *I. deltoides* sp. nov., although it should be stressed that the hinge region of this species is never well preserved. The W/L ratio for *I.* cf. *anglicus elongatus* is 0·66 and this is significantly less (Student's *t*-test, $p < 0·001$) than that for *I. deltoides* sp. nov. (0·89).

The long, gently convex anterior margin forms an acute angle at the beak with an almost straight posterodorsal margin (e.g. KG.1680.72; Pl. 56, fig. 4). The latter is sharply differentiated from a prominent ligamentat which appears to have had a length up to two-thirds that of the total valve length and a height of 1·5–2·0 mm. It bears the remnants of rounded-quadrate to rectangular ligament pits with a mean width in the region of 1 mm; these may be either closely spaced (e.g. KG.1680.30) or separated by interspaces of up to 1 mm. All the specimens are weakly inflated and there are very gentle descents from the centre of the valve to all the margins. On some specimens (e.g. KG.106.3; Pl. 56, fig. 7) the umbo is slightly differentiated from the main body of the valve, but in others (e.g. KG.1680.72, 1681.5; Pl. 56, fig. 4) it is barely discernible as a separate entity. In all cases it terminates in a narrow, pointed beak which does not rise above the level of the hingeline.

The style of ornament is very similar to that seen in the early stages of *I. deltoides* sp. nov. Typically less than 0·5 mm in width at their summits, the ribs are closely and regularly spaced, sub-symmetrical about the growth axis and rounded in cross-section (Pl. 56, figs. 4, 5, 7). There is a slight increase in both rib and interspace width towards the ventral margin of the largest specimens and occasional ribs anastomose or become irregular in their course. The irregularities in the early stage of specimen KG.1680.72 (Pl. 56, fig. 4) may be due to shell damage during growth. Although the right valves are less well preserved than the left valves, it would appear that the species was equivalve.

Remarks. These comparatively small, finely ribbed individuals closely resemble a number of juvenile and incomplete specimens that have been assigned to the *I. anglicus* group (e.g. Imlay 1961, pl. 9, fig. 3; Saveliev 1962, pl. 1, figs. 1–5; Pergament 1965, pl. 1, fig. 3, pl. 4, fig. 3, pl. 5, fig. 2, pl. 9, fig. 6; Glazunova 1973, pl. 19, fig. 5*a*–*c*) (see Table 1). In particular, the broader, more erect forms (e.g. KG.1680.2; Pl. 56, fig. 5) compare well with certain specimens of *I. anglicus forma typica* from Mangishlak (e.g. Saveliev 1962, pl. 1, fig. 5*b*) and the narrower, more oblique ones (e.g. KG.1680.72; Pl. 56, fig. 4) with the subspecies *I. anglicus elongatus* from NW Kamchatka (Pergament 1965, p. 19, pl. 2, figs. 3 and 4; pl. 6, fig. 3). Although lack of a hinge means that the true orientation of some of the Alexander Island material is unknown, it is likely that the majority of specimens are at least slightly obliquely elongated; as such, they are closer to *anglicus elongatus* than *forma typica*. For two of his specimens, Pergament (1965, p. 19) gives lengths of 47 and 44 mm, widths of 32 and 37 mm, and apical angles of 62° and 72°. One of these (Pergament 1965, pl. 2, fig. 3) clearly has a few bifurcating ribs, and, were it not for the fact that no hinge regions are preserved, it would appear that the Russian specimens closely resemble those from Alexander Island. *I. volgensis* from the Aptian of the Russian Platform (Glazunova 1973, p. 43, pl. 12, figs. 1–5) is a finer ribbed species whilst *I. borealis* (Glazunova 1973, p. 43, pl. 13, figs. 4 and 5; pl. 14, figs. 1 and 2; pl. 15, figs. 1–3; pl. 16, figs. 1 and 2), even though it has a similar style of ornament, has a much wider apical angle.

Inoceramus sp. aff. *bellvuensis* Reeside, 1923

Text-fig. 6

cf. 1923 *Inoceramus bellvuensis* Reeside 1923, p. 203, pl. 46, fig. 1.

Holotype. Inoceramus bellvuensis Reeside; USNM 32514 (LV); N of Bellvue, Colorado; Dakota Formation (late Albian–early Cenomanian?) (Reeside 1923, p. 203, pl. 46, fig. 1); by original designation.

Material. KG.1675.3 (ext.m., LV), from Adams Nunatak, Neptune Glacier, Alexander Island (71° 44′ 00″ S., 68° 33′ 30″ W.); KG.1606.16 (ext.m., ?LV) from near the top of a 600 m section on the north-westernmost

TEXT-FIG. 6. *Inoceramus* sp. aff. *bellvuensis* Reeside from the Fossil Bluff Formation of Alexander Island; rubber peel from an external mould of a left valve (KG.1675.3) from Adams Nunatak. ×0·75.

nunatak in the Hyperion Nunataks group (approximately 5 km south of Dione Nunataks) (71° 58′ 30″ S., 68° 59′ 00″ W.; text-fig. 2).

Occurrence. I. bellvuensis is probably late Albian–early Cenomanian in the Western Interior USA (Scott 1970; Kauffman *et al.* 1978). In the Far East of the Soviet Union, specimens referred to *I.* cf. *bellvuensis* by Pergament (1965, p. 22, pl. 4, figs. 1 and 2) occur in association with members of the *I. anglicus* group in Middle–Upper Albian strata.

Description. Specimen KG.1675.3 (text-fig. 6) had an original shell length in excess of 190 mm and a width of at least 140 mm. The outline is judged to have been roughly oval and the orientation slightly oblique; although the hinge is only partially preserved and there has been a certain amount of post-mortem distortion, it would appear that the blunt umbonal region was slightly opisthogyrous. The apical angle of approximately 110° is formed between a comparatively short straight hinge and a long, gently convex anterior margin. The ventral margin is incomplete but the posterior is a long convex feature slightly more strongly curved than the anterior. One of the most striking features of this specimen is the extensive crescent-shape posterior wing which can be traced from the hinge to the ventral margin and has a maximum width in its central region of 50 mm (text-fig. 6). Whereas the umbonal and central regions of the valve are slightly inflated and bear strong, regular concentric ornament, the posterior wing is flat and bears very reduced ornament. The ribs of the former regions are up to 2 mm in width, well rounded in cross-section and separated by flat-floored interspaces of similar dimensions. As they pass on to the wing these ribs sweep strongly forwards and become very much finer (text-fig. 6).

Specimen KG.1606.16 is a less complete left valve with an original shell length in the 90–100 mm range. The ribbing over its umbonal region is similar to that of KG.1675.3 but ventrally some of the ribs fuse in the centre of the valve and have widths of up to 3 mm. There are again indications of a flattened, crescentic posterior wing (up to 18 mm in width) bearing very fine, strongly recurved ribs.

Remarks. The North American species *I. comancheanus* Cragin and *I. bellvuensis* Reeside have generally been regarded as less regularly ribbed members of the *I. anglicus* group (e.g. Reeside 1923; Imlay 1961; Pergament 1965). The latter species, which is the larger and more erect, is characterized by an extensive, flattened, almost smooth posterior region; specimen KG.1675.3 (text-fig. 6) is close to the holotype (Reeside 1923, pl. 46, fig. 1) but has, if anything, a slightly more oval outline. It is also apparent that at least some specimens of *I. bellvuensis* possess a terminal, pointed beak that rises slightly above the hinge and is gently prosogyrous (e.g. Reeside 1923, pl. 46, figs. 1 and 2; Kauffman *et al.* 1978, pl. 7, fig. 9).

Inoceramus sp. aff. *comancheanus* Cragin, 1895

Pl. 56, figs. 6, 8

cf. 1923 *Inoceramus comancheanus* Cragin; Reeside, p. 202, pl. 45, fig. 2.
cf. 1965 *Inoceramus* cf. *comancheanus* Cragin; Pergament, p. 27, pl. 9, figs. 1 and 2.
cf. 1978 '*Inoceramus*' *comancheanus* Cragin; Kauffman, Cobban and Eicher, p. XXIII.29 and pl. 7, fig. 4.

Lectotype. Inoceramus comancheanus Cragin; USNM 32686 (RV); 2–3 miles NE of Denison, Texas; Duck Creek Formation; designated by Kauffman *et al.* (1978, p. XXIII.29 and pl. 7, fig. 4).

Material. KG.1606.18 (int.m., RV); KG.1677.9, 1680.73 (both int.m., LV); KG.1735.11 (int.m. ?RV). Locality KG.1606—near the top of a 600 m section on the north-northwesternmost nunatak of the Hyperion Nunataks group (71° 58′ 30″ S., 68° 59′ 00″ W.); KG.1677—ridge between Mt. Lassell and Mt. Phoebe (71° 45′ 30″ S., 68° 49′ 00″ W.); KG.1680—lower levels, Keystone Cliffs (71° 33′ 00″ S., 68° 15′ 30″ W.); KG.1735—small nunatak 0·6 km W of Mt. Lassell (71° 43′ 30″ S., 68° 52′ 00″ W.) (text-fig. 2).

Occurrence. Associated fossils indicate an undifferentiated Albian age. *I. comancheanus* is Upper Albian–Lower Cenomanian.

Description. These four poorly preserved specimens have lengths in the region of 60 mm and widths of approximately 42 mm. They all have erect profiles, apical angles between 90° and 110°, and weak, somewhat irregular concentric ornament. The anterior margin, which is long and comparatively straight, leads into moderately well-rounded ventral and posterior margins (e.g. Pl. 56, figs. 6 and 8). There are traces of a short, straight hinge and on specimen KG.1680.73 (Pl. 56, fig. 8) four rounded-rectangular ligament pits (measuring approximately $2{\cdot}5 \times 1{\cdot}5$ mm) are preserved. The valves are weakly inflated in the umbonal and anterior regions and compressed posteriorly. Narrow (< 1 mm), fairly regularly spaced concentric ribs cover the former of these regions but they become noticeably less distinct on the posterior (e.g. KG.1606.18; Pl. 56, fig. 6). In places the course of the ribs is irregular and on specimen KG.1680.73 (Pl. 56, fig. 8) they are slightly asymmetric about the growth axis.

Remarks. The slightly irregular style of ornament and flattened, faintly ribbed posterior region links these specimens with *I. comancheanus* Cragin. Although this species is usually regarded as an obliquely elongated one (e.g. Reeside 1923, pl. 45, figs. 1, 3, 4, 6, 7; Eigenheer and Sornay 1974, pl. 1, fig. *a*), it does include some more erect individuals (e.g. Reeside 1923, pl. 45, figs. 2 and 5; Kauffman *et al.* 1978, pl. 7, fig. 4). The density of ribbing on the Antarctic specimens is perhaps not so high as is usually encountered on *I. comancheanus* and there is also less of a tendency for individual ribs to split (Pl. 56, figs. 6 and 8). Nevertheless, Pergament (1965, p. 27, pl. 9, figs. 1 and 2) has illustrated two specimens of *I.* cf. *comancheanus* from the Middle–Upper Albian of the Soviet Far East with regular, more widely spaced ornament and these are comparable to the Alexander Island material.

Inoceramus carsoni group
Inoceramus carsoni M'Coy, 1865

Plate 57, figs. 1–3; Plate 58, fig. 2a, b; text-fig. 7

1865 *Inoceramus carsoni* M'Coy, p. 334.
1866 *Inoceramus carsoni* M'Coy; M'Coy, p. 50.
1867 *Inoceramus carsoni* M'Coy; M'Coy, p. 196.
1872 *Inoceramus pernoides* Etheridge (*non* Goldfuss), p. 343, pl. 22, fig. 3.
1892 *Inoceramus carsoni* M'Coy; Etheridge Jr., p. 463 (*non* pl. 25, figs. 9 and 10 = *I. sutherlandi*).
1892 *Inoceramus pernoides* Etheridge; Etheridge Jr., p. 464, pl. 25, figs. 7, 8, 12.
1892 *Inoceramus* sp. indet.; Etheridge Jr., pl. 21, fig. 19.
1901 *Inoceramus etheridgei* Etheridge Jr. (*non* Woods), p. 22.
1905 *Inoceramus etheridgei* Etheridge Jr., p. 13, pl. 2, figs. 7–9.
1928*b* *Inoceramus pictus* Sowerby; Heinz, p. 129 (*pars*).
1966 *Inoceramus carsoni* M'Coy; Ludbrook, p. 157, pl. 17, figs. 2 and 3.

Lectotype. P.2712 (RV) (National Museum of Victoria): base of Walker's Table Mountain, W bank of Flinders River, Queensland; Albian; designated by Ludbrook (1966, p. 157 and pl. 17, fig. 3).

Material. D.8411.11, 12*b*, 13, 16, 8412.73, 8413.1, 8422.96*c*, 108, 114, 134–136, 8424.3 (all int.m., RV); D.8412.57 (int.m., ?RV); D.8411.12*a*, 14, 17, 37, 38, 58, 8412.59–61, 8422.66, 69, 74*b*, 75, 76, 80, 89, 95, 96*a*, *b*, 122–127, 131, 132, 137, 141, 8424.4*a*–*c* (all int.m., LV); D.8422.70 (ext.m., LV); D.8411.10, 15, 61, 66, 8412.62, 66, 68, 74, 75, 8413.3, 8422.64, 65, 71–74, 77, 78, 89, 97–99, 106, 115–117, 127–129 (probable juveniles). Localities D.8411 and 8413—reworked nodules in a breccio-conglomerate unit at 151 m in the composite 346 m section (D.8515–8518) at N end of Tumbledown Cliffs, NW James Ross Island (64° 03′ 50″ S., 58° 26′ 00″ W.); D.8412—67–121 m interval in the same section; D.8422 and 8424—uppermost 121.5 m of a 483.5 m section (D.8521–8523) in Lost Valley, NW James Ross Island (64° 02′ 20″ S., 58° 24′ 10″ W.) (text-figs. 3 and 11).

Occurrence. As for material; associated throughout both the Lost Valley and Tumbledown Cliffs sections with *Maccoyella* and *Ancellina* (? *A. hughendenensis* (Etheridge)). An upper Albian age inferred for the James Ross

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EXPLANATION OF PLATE 57

Figs. 1–3. *Inoceramus carsoni* M'Coy from NW James Ross Island. 1, internal mould of right valve (D.8422.136); Lost Valley, $\times 0{\cdot}75$. 2, internal mould of left valve (D.8422.123); same locality, $\times 1$. 3, internal mould of right valve (D.8413.1); northern Tumbledown Cliffs, $\times 1$.

1

2

3

CRAME, *Inoceramus* from Antarctica

Island material by analogy with Great Artesian Basin faunas (Ludbrook 1966; Day 1969), is compatible with the occurrence of the ammonite *Ptychoceras* at approximately the 466 m level in the Lost Valley section and presence of *B. concentrica* and a turrilitid ammonite in the upper levels of the Tumbledown Cliffs section (text-fig. 11).

TEXT-FIG. 7. *Inoceramus carsoni* M'Coy; internal mould of a large left valve (D.8422.132) from Lost Valley, NW James Ross Island. ×0·75.

Description. Adult specimens have a mean shell length of 105·33 mm (S.D. = 39·36; range = 56–225; N = 46) and a mean width of 58·26 mm (S.D. = 21·56; range = 28–127; N = 46). With their narrow, pointed umbones and broader, rounded ventral regions, they have a distinctive mytiloid (or pernoid) outline, although it is noticeable that the orientation (with respect to a horizontal hinge) varies from sub-erect to strongly oblique (e.g. Pl. 57, figs. 1–3; text-fig. 7). In the more erect forms the long anterior margin varies from almost straight to a sigmoidal curve composed of an initial concave portion beneath the umbonal region and a subsequent long, gently convex portion (e.g. D.8413.1; Pl. 57, fig. 3). The posterodorsal margin in these types is usually slightly convex and the posteroventral and ventral margins well rounded. In the obliquely elongated forms the anterior region is usually divisible into an early short sigmoidal section and a later, and much longer, gently convex one (e.g. D.8411.12, 8422.132; Pl. 58, fig. 2*a* and text-fig. 7). The latter lies subparallel to the long, feebly convex posterodorsal border and there is a narrow, very convex ventral region. As might be expected the obliquely elongated specimens are consistently narrower than the more erect ones, and have W/L values well below 0·5. Some of the erect types are narrow too, but others show a pronounced trend towards ventral expansion (e.g. D.8422.136; Pl. 57, fig. 1); overall, a mean W/L value of 0·56 was obtained (S.D. = 9·35; range = 0·36–0·76; N = 46). The hinge, which is never well preserved, is short and straight and sometimes forms a low, oblique-angled wing at its junction with the posterodorsal margin (e.g. D.8411.12; Pl. 58, fig. 2*a*). The umbo rises sharply above the hinge, curves moderately strongly forwards and inwards, and terminates in a narrow, acuminate beak. The slim form of the whole umbonal region is reflected in the narrow apical angle ($\bar{x}$ = 62·85°; S.D. = 10·61; range = 46–92°; N = 47).

From the umbonal region, which is moderately inflated, there is typically a steep descent to the anterior margin and a slightly less sharp one to the posterodorsal border. There is also a smooth, even gradient to the ventral region, which, in the largest specimens, is almost flat (e.g. D.8422.132, 136; Pl. 57, fig. 1 and text-fig. 7). The basic ornament pattern is one of simple, narrow (< 1 mm) concentric rings (*Anwachsringen* of Heinz 1928*a*) that are remarkably regular in their course and distribution; very few tapering or anastomosing ribs are seen. The only significant variation in ornament style is in the rib density, with some specimens having interspaces of only slightly greater dimensions than the ribs (e.g. D.8411.12; Pl. 58, fig. 2*b*) and others exhibiting a spacing of 3–4 mm, especially in their ventral regions (e.g. D.8413.1; Pl. 57, fig. 3). Very occasionally, interspaces up to 10 mm in width developed, and on the largest specimen (D.8412.57), which has an estimated length of 215 mm, there is evidence of extensive disruption of coarsely spaced ribs in the ventral region. Some of the closely spaced ornament shows signs of being grouped on low primary folds into *Anwachsringreifen* (e.g. D.8411.12, 8422.132; Pl. 58, fig. 2*b* and text-fig. 7). Although no adult whole specimens were found, it is judged that this species was equivalve, or very nearly so.

Juvenile specimens tend to have more erect profiles than adults and less obviously protruding umbonal regions. Nevertheless, the umbones are still consistently narrow and at least some terminate in slender, pointed beaks. Many juveniles display closely spaced *Anwachsringen* ornament.

Remarks. The narrow, pointed and strongly projecting umbones of these specimens, together with their sub-erect to obliquely elongate form and simple, regular concentric ribs, readily link them to the Australian *I. carsoni* group (Table 1). In particular the comparatively low width to length ratio, shallow sigmoidal curve of many of the anterior margins, and predominance of fine, closely spaced ornament, suggest that they are closest to *I. carsoni* itself (cf. Etheridge 1872, pl. 22, fig. 3; Etheridge Jr. 1892, pl. 25, figs. 7, 8, 12; Etheridge Jr. 1905, pl. 2, figs. 7–9; Ludbrook 1966, pl. 17, figs. 2 and 3; Hill *et al.* (ed.) 1968, pl. K.V., fig. 11). However, it should be stressed here that the principal distinction between *I. carsoni* and *I. sutherlandi* is one of size, with the latter being broader, and usually longer, than the former (M'Coy 1865, 1866, 1867; Ludbrook 1966, p. 159). It is not always easy to separate large *carsoni* from small *sutherlandi* and the possibility that some of the Antarctic specimens may be at least transitional to *sutherlandi* should be born in mind. Specimen D.8411.12 (Pl. 58, fig. 2*a*), for example, has a higher than average ventral expansion for its length and approaches some small forms of *sutherlandi* (cf. Ludbrook 1966, pl. 17, figs. 4 and 6), whilst one of the largest specimens, D.8422.136 (Pl. 57, fig. 1), has a distinctive rounded-triangular form that may be better accommodated in *sutherlandi* than *carsoni* (cf. Ludbrook 1966, pl. 18, fig. 1). Re-examination of the extensive Australian material may yet show that these two species can be combined.

Inoceramus cf. *sutherlandi* M'Coy, 1865

Plate 58, fig. 1

cf. 1865 *Inoceramus sutherlandi* M'Coy, p. 334.
cf. 1866 *Inoceramus sutherlandi* M'Coy, p. 50.
cf. 1867 *Inoceramus sutherlandi* M'Coy, p. 196.
cf. 1872 *Inoceramus* allied to *I. problematicus* d'Orbigny; Etheridge, p. 344, pl. 22, fig. 4.
cf. 1889 *Inoceramus maximus* Lumholtz, p. 367, fig.
cf. 1892 *Inoceramus carsoni* M'Coy (pars); Etheridge Jr., p. 463, pl. 25, figs. 9 and 10.
cf. 1892 *Inoceramus sutherlandi* M'Coy; Etheridge Jr., p. 463.
cf. 1901 *Inoceramus maximus* Lumholtz; Etheridge Jr., p. 24.
cf. 1924 *Inoceramus maximus* Lumholtz; Whitehouse, p. 128, pl. 7, figs. 1 and 2*a*, *b*.
cf. 1928*b* *Inoceramus sutherlandi* M'Coy; Heinz, p. 144.
cf. 1966 *Inoceramus sutherlandi* M'Coy; Ludbrook, p. 157, pl. 18, fig. 1.

Holotype. *Inoceramus sutherlandi* M'Coy; P.2170 (RV) (National Museum of Victoria): base of Walker's Table Mountain, Flinders River, Queensland; Albian; illustrated by Ludbrook (1966, pl. 18, fig. 1).

Material. D.8403.53–57: numerous large, incomplete valves contained within a series of mudstone concretions; approximately the 200 m level in the section measured at Kotick Point (D.8403, 64° 00′ S., 58° 21′ W.), NW James Ross Island (text-figs. 3 and 11).

Occurrence. As for material. Lithological correlations between the Kotick Point and Lost Valley sections indicate that *I*. cf. *sutherlandi* occurs approximately 100–150 m beneath the first appearance of *I. carsoni* (text-fig. 11). The specimens are associated with *Aucellina* and probable representatives of the ammonite *Silesites*. Both these types are present at approximately the 900–1000 m level in the Brandy Bay–Whisky Bay area (text-fig. 11) in Aptian–Albian beds that have also yielded *I. stoneleyi* sp. nov. and *Anopaea* sp. nov. *β*. *I. sutherlandi* is an Upper Albian species in Australia (Ludbrook 1966; Day 1969).

Description. There are indications that some of these specimens had lengths and widths in excess of 150 mm, and occasionally substantially more. The prismatic shell layer is in places up to 4 mm thick and it is readily apparent that the original species was a broad, thick-shelled form. Some idea of the original form can be obtained from three imperfect internal moulds of right valves (D.8403.53*a*, *b* and 57); these have estimated lengths of 144, 142, and 110 mm, corresponding widths of 105, 107, and 88 mm, and W/L values of 0·73, 0·75, and 0·80. Specimens D.8403.53*a* and *b* seem to have erect, rounded-triangular outlines, with narrow, pointed umbones and much broader, rounded ventral regions. They are moderately and evenly inflated and exhibit smooth, gentle descents from the centre of the valve to the ventral margins and slightly steeper ones from the umbonal region to the antero- and posterodorsal margins. The umbones, which are not sharply differentiated from the valve surface, curve gently forwards and inwards and appear to taper to a point.

Specimen D.8403.57 (Pl. 58, fig. 1) also has an erect profile but seems to have been considerably broader than the previous two. In addition, it is more strongly inflated in the umbonal region and there is an almost vertical descent from the latter to the anterodorsal margin. There is a shallower gradient in the opposite direction to the posterodorsal region, which is considerably extended by the presence of an extensive, flat, obtuse-angled wing. This feature is separated from the inflated umbo by a well-marked radial groove and bordered dorsally by the remnants of a long, straight hinge. On all three specimens there are only very faint traces of shallow, widely spaced, concentric folds.

Remarks. These broad, erect, almost smooth valves immediately invite comparison with medium-sized and large forms of *I. sutherlandi* (e.g. *I. maximus* Lumholtz 1889, fig. on p. 367; *I. carsoni* M'Coy in Etheridge Jr. 1892, pl. 25, fig. 9; *I. maximus* Lumholtz in Whitehouse 1924, p. 128, pl. 7, figs. 1 and 2; all of which = *I. sutherlandi* in Ludbrook 1966, p. 157). The holotype itself (Ludbrook 1966, pl. 18, fig. 1) is very similar in style to these specimens, although of somewhat larger dimensions (L = 187 mm, W = 130 mm). It should be noted, however, that the posterodorsal wing on specimen D.8403.57 (Pl. 58, fig. 1) is rather more clearly defined than that normally seen on *I. sutherlandi* and that the Antarctic specimens lack sigmoidally curved anterior margins. It is only possible, at present, to suggest a tentative assignment to *I. sutherlandi*.

Inoceramus of uncertain group affinity

Inoceramus annenkovensis sp. nov.

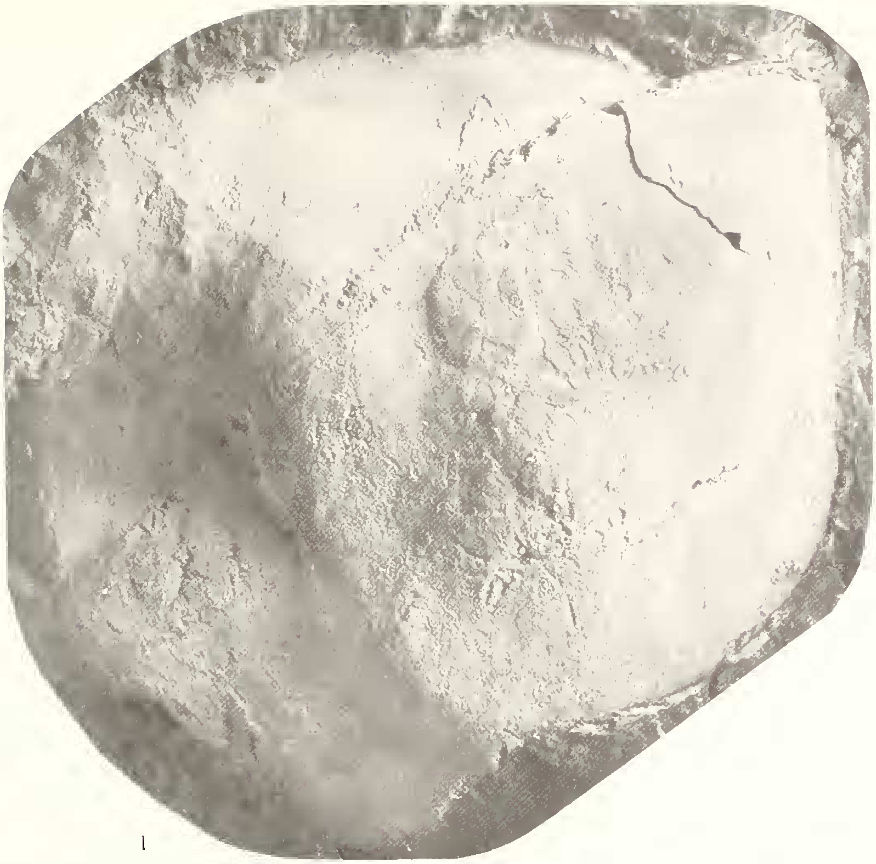
Text-fig. 8*a–c*

1947 *Inoceramus* sp.; Wilckens, p. 37, pl. 5, figs. 2–4.
?1982 *Inoceramus* sp.; Thomson, Tanner and Rex, p. 179, fig. 19.2*g*.

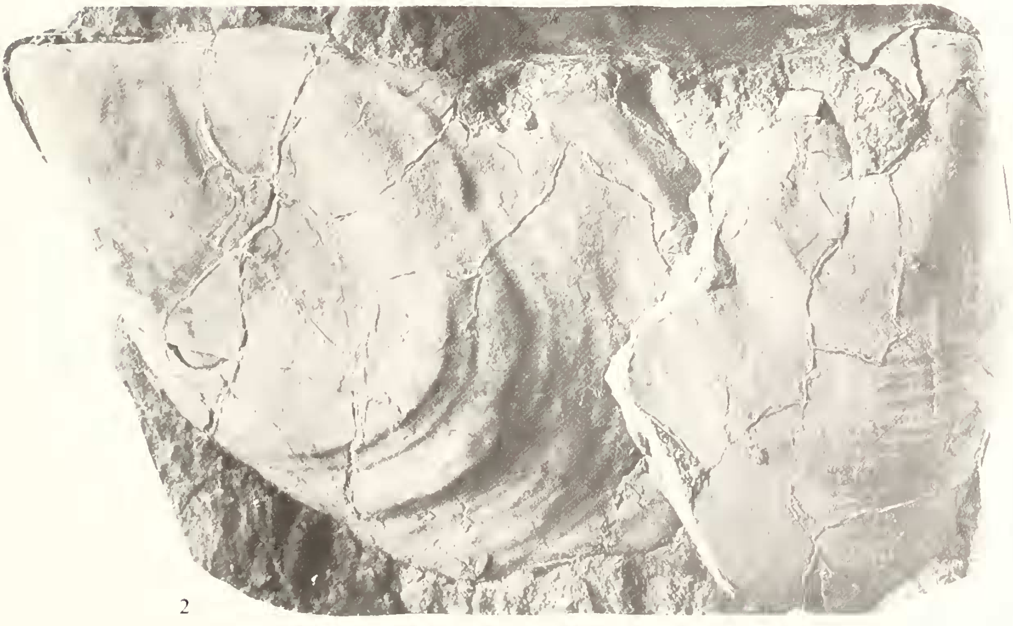
EXPLANATION OF PLATE 58

Fig. 1. *Inoceramus* cf. *sutherlandi* M'Coy. Internal mould of right valve (D.8403.57); Kotick Point, NW James Ross Island, × 1.

Fig. 2. *Inoceramus carsoni* M'Coy. *a* (*left*), internal mould of left valve (D.8411.12*a*); *b* (*right*), internal mould of right valve (with traces of shell material) (D.8411.12*b*); specimens from northern Tumbledown Cliffs, James Ross Island, × 1.



1



2

CRAME, *Inoceramus* from Antarctica

Type material. Holotype: M.1165.30*c*.1 (int.m., RV). Paratypes: M.1165.30*c*.2, 1165.32*a* (both int.m., RV); M.1165.32*b* (ext.m., ?RV); M.1165.32*c* (int.m., indet. V). Locality M.1165 occurs at approximately the 518·5 m level in the Lower Tuff Member, Annenkov Island (54° 29′ S., 37° 03′ W.; text-fig. 1) (Pettigrew 1981, fig. 5; Crame 1983*a*, figs. 6 and 7).

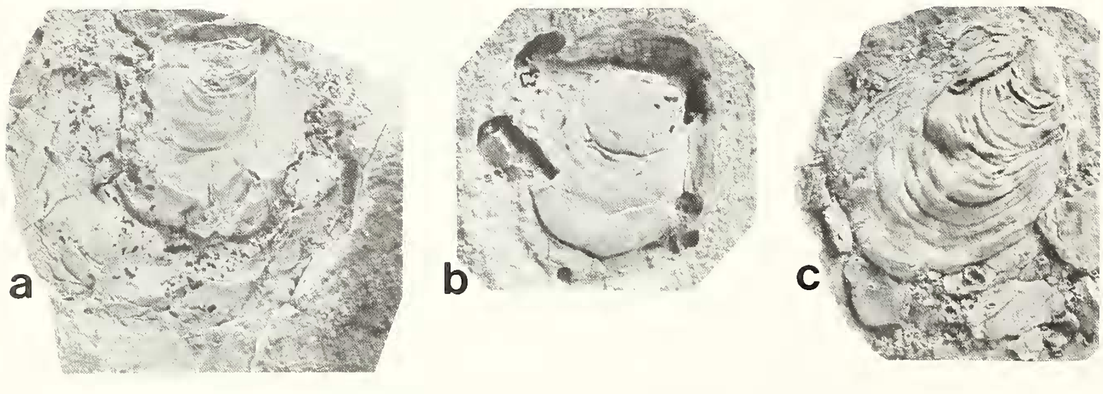
Occurrence. As for material. The Annenkov Island Formation is imprecisely dated in the interval Neocomian–Aptian (Thomson *et al.* 1982). The overlying species, *I.* cf. *heteropterus*, suggests a late Hauterivian age and the closely related species, *I. anomiaeformis*, a Hauterivian–Barremian one.

Derivation of name. From the occurrence on Annenkov Island.

Diagnosis. A small, weakly inflated *Inoceramus* with a rounded, sub-symmetrical outline; irregular and ill-defined ornament is mainly confined to the umbonal region; prominent ligamentat comprises a sequence of complex ligament pits; equivalence of valves undetermined.

Description. The holotype has a length and width of 44 mm and specimens M.1165.32*b* and *c* are of similar dimensions; M.1165.32*a* and M.1165.30*c*.2, however, are significantly smaller, with lengths and widths in the 20–25 mm range. The outline appears to be well rounded and the holotype is sub-symmetrical about an axis joining the midpoints of the dorsal and ventral margins (text-fig. 8*a*). All the valves are weakly inflated, with the only significant convexity occurring in the umbonal region. A steep descent from the latter towards the anterodorsal margin leads into a narrow, concave gutter which, on the holotype, has a length of approximately 10 mm and a maximum width of 3 mm. At its deepest directly beneath the umbo, this feature progressively diminishes in strength when traced in a ventral direction (text-fig. 8*a*).

The umbo is slightly prosogyrous and terminates in a narrow, pointed beak (text-fig. 8*a*). Although the tip of the latter must have been approximately level with the dorsal surface of the hinge, it was separated from it by another narrow, deep gutter (text-fig. 8*a*). This feature merges anteriorly with the anterodorsal gutter and also diminishes in intensity when traced in a direction away from the umbo (i.e. posteriorly). The ligamentat is well preserved on M.1165.30*c*.2 (text-fig. 8*b*) and partially preserved on M.1165.30*c*.1 and M.1165.32*a*. On the former two of these specimens it can clearly be seen to slope steeply inwards towards the plane of commissure between the valves; this indicates that the ligament area had a 'V' shaped cross-section. The ligamentat varies from 15–20 mm in length and 2–3 mm in depth and comprises somewhere between seven and ten ligament pits. These pits are complex features with essentially rounded-quadrate to rounded-rectangular outlines and at least two structural elements. On specimen M.1165.30*c*.2 these can be resolved into a simple, striated, square, or rectangle which alternates with a more deeply impressed figure 'J' (text-fig. 8*b*).



TEXT-FIG. 8. *Inoceramus annenkovensis* sp. nov. from Annenkov Island. *a*, holotype, internal mould of a right valve (M.1165.30*c*.1). *b*, internal mould of a right valve (M.1165.30*c*.2). *c*, latex peel from external mould of a probable right valve (M.1165.32*b*). All specimens × 1.

The ornament on four of the specimens (M.1165.30*c*.1, 2; M.1165.32*a*, *c*) is extremely weak and irregular. Narrow, concentric ribs can be made out over the umbonal regions but these vary from acute to well rounded in profile and are noticeably irregular in their distribution (text-fig. 8*a*, *b*). On the holotype (M.1165.30*c*.1) and specimen M.1165.32*c*, this style of ornament rapidly diminishes away from the umbo and much of the ventral surface of the valve has an uneven, undulatory appearance (text-fig. 8*a*). Stronger ornament is preserved on the external mould (M.1165.32*b*), which, at first sight, seems to be readily distinguishable from the other material by its slightly posteriorly directed umbo (text-fig. 8*c*). Nevertheless, it is apparent that this specimen has been crushed and it very probably is a right valve with a slightly displaced umbo. Narrow, irregular ribs with acute summits on the earliest shell stages give way ventrally to closely spaced ones with rounded summits and widths in the 1–2 mm range. These ribs, which are slightly erratic in their course and variable in thickness, sweep strongly forwards to fuse along the anterior margin (text-fig. 8*c*). On the posterior and ventral margins there are indications of a marked reduction in rib intensity.

Specimen M.1165.32*b* is of particular importance as it provides a possible link with a hitherto unique specimen of *Inoceramus* previously described from the Lower Tuff Member of Annenkov Island (*Inoceramus* sp. of Thomson *et al.* 1982, p. 179, fig. 19.2*g*). This external mould of a whole specimen was collected loose from locality L on Lawther Knoll (Thomson *et al.* 1982, fig. 19.1) and thus probably came from a stratigraphic level equivalent to either station M.1165 or M.1196 (Pettigrew 1981, fig. 2). It has clearly defined, narrow, and closely spaced concentric ornament that shows some considerable similarities in style to that of specimen M.1165.32*b* (cf. text-fig. 8*c* and Thomson *et al.* 1982, fig. 19.2*g*). Although both valves appear to be mytiliform, it is apparent that this specimen has been crushed and that the anterior margins may have been foreshortened.

Remarks. The three small, rather poorly preserved specimens of *Inoceramus* sp. described by Wilckens (1947, p. 37, pl. 5, figs. 2–4) from the north-east coast of Annenkov Island most likely belong within this new species. Their outlines are slightly more elongate than those of the valves just described, but in degree of inflation and ornament pattern they agree closely. They were collected from a series of localities that are very close to Pettigrew's (1981, fig. 2) M.1153 and locality J of Thomson *et al.* (1982, table 19.1); thus, they probably originate from somewhere within the lowest 80 m of the Lower Tuff Member (Pettigrew 1981, fig. 5; Crame 1983*a*, figs. 6, 7). The only existing species with which *I. annenkovensis* sp. nov. could be compared is *I. anomiaeformis* Feruglio (1936, p. 29, pl. 2, figs. 1 and 2) from Tithonian–Lower Cretaceous strata of the Lago Argentino region of Patagonia. This species was based on the internal moulds of two rounded, almost symmetrical, right valves, the larger of which (Feruglio 1936, pl. 2, fig. 1) was subsequently designated the lectotype (Leanza 1967, p. 150). This specimen has a moderately inflated, centrally positioned umbo whose tip is turned very slightly forwards. Either side of the umbo are two small, subequal ears that are moderately well differentiated from the main disc of the valve. On both Feruglio's illustrated specimens there is an ornament of fine narrow concentric ribs that occasionally anastomose or intergrade. This style of ornament is close to that of *I. annenkovensis* sp. nov., but the subsymmetrical form, distinct ears, and apparent lack of a prominent ligamentat probably serve to distinguish it as a separate species. Riccardi (1977, p. 222, fig. 2*a*) has described a single incomplete specimen of *I.* aff. *anomiaeformis* from the Springhill Formation of southern Patagonia which is notable for the more pointed, prosogyrous form of its umbones as well as its indistinct ornament. It may well provide a link with the Annenkov Island specimens but at present there is insufficient material available for this to be firmly established. In Patagonia, *I. anomiaeformis* occurs in association with the ammonite *Favrella* in beds that are generally assigned to the Hauterivian–Barremian (Riccardi 1970, 1977; Riccardi *et al.* 1971).

Genus *Birostrina* J. Sowerby, 1821

1864 *Actinoceramus* Meek.

Type species. *Inoceramus sulcatus* Parkinson, 1819, from the Gault (middle–upper Albian) of Folkestone, England; by subsequent designation (Cox 1969, p. N315).

Birostrina concentrica group
Birostrina concentrica Parkinson, 1819

Plate 59, figs. 1–11, 13

1819 *Inoceramus concentricus* Parkinson, p. 58, pl. 1, fig. 4.
1821 *Inoceramus concentricus* Parkinson; J. Sowerby, p. 183, pl. 305, figs. 1–6.
1846 *Inoceramus concentricus* J. Sowerby; d'Orbigny, p. 506, pl. 404, figs. 1–5.
1876 *Inoceramus concentricus* Parkinson; Whiteaves, p. 79.
1904 *Inoceramus concentricus* Parkinson; Airaghi, p. 183, fig. 2.
?1907 *Inoceramus volviumbonatus* Etheridge, p. 73, pl. 2, figs. 1–6.
1911 *Inoceramus concentricus* Parkinson; Woods, p. 265, pl. 45, fig. 11; pl. 46, figs. 1–10; pl. 47, figs. 1 and 2.
?1911 *Inoceramus concentricus* Parkinson; Schlagintweit, p. 94.
1917 *Inoceramus concentricus* Parkinson; Woods, p. 9, pl. 3, figs. 9 and 10.
?1921 *Inoceramus concentricus* Parkinson; Bonarelli and Nágera, p. 22, pl. 2, fig. 9.
1930 *Inoceramus concentricus* Parkinson; Heinz, p. 683, fig. 1.
1933 *Actinoceramus* (*Taenioceramus*) *concentricus* Parkinson; Heinz, p. 245.
1936 *Inoceramus concentricus brasiliensis* (White); Maury, p. 107, pl. 8, figs. 9, 10, 13.
?1939 *Inoceramus concentricus* Parkinson var. *nipponicus* Nagao and Matsumoto, p. 267, pl. 24, fig. 2; pl. 25, figs. 1–6.
?1939 *Inoceramus concentricus* Parkinson var. *costatus* Nagao and Matsumoto, p. 270, pl. 24, figs. 1, 4, 5; pl. 27, fig. 2.
?1960 *Inoceramus* (*Actinoceramus*) *concentricus* Parkinson; Jones, p. 157, pl. 29, figs. 1 and 2.
1962 *Inoceramus concentricus* Parkinson; Saveliev, p. 235, pl. 7, figs. 3–7 and pl. 8, figs. 1 and 2.
?1966 *Inoceramus* cf. *concentricus* Parkinson; Pergament, p. 30, pl. 1, figs. 1–4.
?1976 *Inoceramus* (*Inoceramus*) *concentricus* Parkinson; Chiplonkar and Badve, p. 199, pl. 1, fig. 5.
1978*a* *Birostrina concentrica* (Parkinson) (*sensu lato*); Kauffman, p. IV.2.
1978*b* *Birostrina concentrica* (Parkinson) (*sensu lato*); Kauffman, p. XVII.1 and pl. 1, figs. 1–3, 5–; 4, 16, 18.
1978 *Birostrina concentrica* (Parkinson) (*sensu lato*); Wiedmann and Kauffman, p. III.4, pl. 1, figs. 1–10 and 12–14.
1980 *Inoceramus concentricus* Parkinson; Crame, p. 283, fig. 2*a*–*c*.

N.B. this synonymy comprises only those references that were useful in identifying the Antarctic material. No attempt has been made here to fully revise all the European and Japanese specimens of *I. concentricus*. Woods

EXPLANATION OF PLATE 59

Figs. 1–11, 13. *Biostrina concentrica* (Parkinson) from James Ross and Dundee Islands. 1, anterior view of internal mould of a whole specimen (D.8228.12); Brandy Bay. 2, posterodorsal view of internal mould of a whole specimen (D.8228.5); umbonal region of the left valve slightly displaced across that of the right; same locality. 3, internal mould of a whole specimen (D.8413.58) that bears traces of a thin prismatic shell layer; viewed from the right side; northern Tumbledown Cliffs. 4, internal mould of a whole specimen (D.3862.6), viewed from the right side; Welchness (Dundee Island). 5, internal mould of left valve (D.8227.5); Whisky Bay. 6, internal mould of left valve (D.8214.13); small gully approximately 2 km E of Stoneley Point. 7, internal mould of left valve (D.8214.31); same locality. 8, left valve of specimen D.8228.5 viewed from the anterior. 9, internal mould of left valve (D.8413.42); northern end of Tumbledown Cliffs. 10, internal mould of left valve (D.8413.38); same locality. 11, internal mould of right valve (D.8214.29); small gully approximately 2 km E of Stoneley Point. 13, internal mould (with traces of prismatic shell) of right valve (D.8215.11); gully approximately 3 km ENE of Stoneley Point. All the specimens are from NW James Ross Island, except for fig. 4 which is from western Dundee Island. All $\times 1$, except for fig. 1 which is $\times 1{\cdot}5$.

Figs. 12 and 14. *Birostrina*? cf. *concentrica* (Parkinson) from the Fossil Bluff Formation of Alexander Island. 12, rubber peel from external mould of right valve (KG.1680.74); Keystone Cliffs. 14, internal mould (with traces of shell material) of small right valve (KG.2801.250); northern end of Succession Cliffs. Both specimens $\times 1$.

CRAME, *Birostrina* from Antarctica

(1911) and Saveliev (1962) contain references to a number of early European works not cited here and Kauffmann (1977) gives a preliminary revision of the Japanese forms.

Type specimen. Inoceramus concentricus Parkinson (1819, p. 58, pl. 1, fig. 4); by monotypy.

Material. D.3862.6, 8215.3, 28, 8227.6, 8, 8228.5, 10, 12, 14, 20, 8413.58, 60, 8414.4, 5, 8431.97, 98, 8531.1 (all int.m., WS); D.8214.3, 5, 6, 8, 13, 30, 31, 37, 39, 40, 44, 45, 48, 50, 8215.1, 4, 9, 12–14, 16, 25, 8227.5, 10, 12, 8228.2, 3, 7, 13, 16, 19, 8413.35–42, 59, 8414.6, 8531.5–11, BR.151.2 (all int.m., LV); D.8414.8, 8431.95 (int.m., ?LV); D.8214.4, 7, 9, 12, 14–17, 20, 22, 26–29, 32, 33, 42, 46, 51, 52, 8215.2, 7, 11, 19, 20, 23, 8227.11, 13, 8228.6, 11, 17, 18, 8344.1, 3, 8413.43, 44, 8431.96, 8531.2–4, BR.151.1, 4, 5*a*, *b*, 6, 10 (all int.m., RV); D.8414.7 (int.m., ?RV); D.8413.69 (ext.m., RV). Many of the internal moulds bear traces of a thin outer shell layer. All the following localities (except for D.3862 and BR.151) are on NW James Ross Island (text-fig. 3): D.8214—small gully approx. 2 km E of Stoneley Pt. (63° 52′ S., 58° 04′ 30″ W.); D.8215—small gully approx. 4 km ENE of Stoneley Pt. (63° 51′ 15″ S., 58° 03′ 20″ W.); D.8227—NE shore of Whisky Bay (63° 52′ 40″ S., 58° 06′ 55″ W.); D.8228—SW shore of Brandy Bay (63° 51′ S., 58° 01′ W.); D.8344—2 km E of Bibby Pt. (63° 48′ 20″ S., 57° 54′ 30″ W.); D.8413—N of Tumbledown Cliffs (64° 03′ 00″ S., 58° 24′ 30″ W.); D.8431/8531—S end of Tumbledown Cliffs (64° 05′ 00″ S., 58° 26′ 40″ W.); D.3862/BR.151—moraine ridge, Welchness, Dundee Island (63° 29′ S., 56° 15′ W.) (text-fig. 1).

Occurrence. As for material. On James Ross Island, *B. concentrica* is associated with an Albian–Cenomanian turrilitid ammonite in the northern Tumbledown Cliffs assemblage (D.8413) and at locality D.8414 (text-fig. 3). In the combined section for western James Ross Island (text-fig. 11) it occurs 125 m above the highest occurrence of *I. carsoni* and approximately 400 m above the *I. stoneleyi* sp. nov.—*Silesites* assemblage of the Whisky Bay–Brandy Bay area.

The Middle–Upper Albian age range established by Woods (1911, 1912) for *B. concentrica* has been widely accepted by other authors (e.g. Pergament 1981; Tröger 1981). However, the possibility that this species both extends into the top of the Lower Albian and the base of the Lower Cenomanian should not be discounted (Kauffman 1978*a*, fig. 1; Sornay 1981). If forms such as *I. concentricus nipponicus* and *I.* cf. *concentricus* (Pergament 1966) prove to be true members of the *B. concentrica* group (see Table 1), then extension of the range into well within the Cenomanian will be established. There is also a possibility of Cenomanian representatives of '*I. concentricus*' in New Zealand (see below). Other definite Southern Hemisphere occurrences of *B. concentrica* are in South Africa (Middle–Upper Albian of Zululand; Heinz 1930; Kauffman 1978*b*) and Brazil (?Middle–Upper Albian; Maury 1936), whilst there are further possible records from the Albian of Argentinian Patagonia (Bonarelli and Nágera 1921) and the Albian of Madagascar (Heinz 1933).

Description. The James Ross Island specimens agree closely with those previously described from Dundee Island (Crame 1980, p. 283). They are comparatively small, with the left valves having a mean shell length of 34·48 mm (S.D. = 8·58; range = 16–56; N = 42) and the right valves 26·88 mm (S.D. = 7·49; range = 11–50; N = 49). These respective mean shell lengths are significantly different (Student's *t*-test, $p < 0{\cdot}001$) and attest to the strongly gryphaeoid form of the species. This is clearly exhibited by the whole specimens, each of which has a left valve with an inflated umbonal region that towers over that of the right (e.g. D.3862.6, 8228.5, 12, 8413.58; Pl. 59, figs. 1–4). The larger volume of material from James Ross Island enables the range of variation of this biostratigraphically important species to be more fully assessed.

The outline of the left valve is variable and at least three main types can be made out: obliquely elongated, elongate-pyriform, and rounded-quadrate. The first of these is the most strongly asymmetric, possessing a comparatively narrow, pointed umbonal region that slopes gently forwards (e.g. D.8214.13 and 8227.5; Pl. 59, figs. 5 and 6); the second is more upright and pear- (or tear-)shaped (e.g. D.8214.31, 8228.5, 12; Pl. 59, figs. 1, 7, 8); and the third is similar to the second but considerably squatter (e.g. D.8413.38; Pl. 59, fig. 10). No rigid morphologic or stratigraphic divisions can be placed between these types and it is almost certain that they intergrade. In profile, all the left valves are strongly convex (i.e. incurved) and in lateral view the maximum degree of inflation can be seen to lie in the central regions of the valve and along the growth axis. The form of the central region varies from a broad, shallow dome, with only moderate descents on either side (e.g. D.8227.5; Pl. 59, fig. 5) to a narrow, strongly convex ridge that is bounded laterally by extremely steep drop-offs (e.g. D.8228.5 and 8413.42; Pl. 59, figs. 2, 8, 9). A particularly noticeable feature of all the left valves is the almost vertical descent along the anterior margin; this forms a prominent flat, smooth shelf of anything up to 15 mm in height. There is a shallower descent to the ventral and posterior margins and at the posterodorsal extremity a small flange-like wing is delimited by a sharp break in slope on one side and the short, straight hinge on the other. The strongly incurved, slightly to strongly prosogyrous umbo rises above the hingeline by anything up to 11 mm and frequently tapers to a beak of less than 2 mm width. The apical angle generally lies in the 85°–95° range.

The smaller right valve of *B. concentrica* has an erect outline and is typically somewhat longer than wide ($\bar{x}$ W/L = 0·71; S.D. = 0·12; range = 0·48–1·08; N = 61) (e.g. D.8215.11; Pl. 59, fig. 13); there are, however, both occasional narrow, elongate forms and squatter, rounded ones. The hinge typically forms an apical angle with the anterior margin of between 90° and 110°. The latter feature is straight to very slightly concave and usually measures at least half the total shell length. It leads into well-rounded anteroventral, ventral, and posteroventral margins, but the posterior margin proper is less steeply curved (Pl. 59, fig. 13). The small, prosogyrous umbo, which is not nearly so prominent as that on the left valve, does not rise above the hingeline and a narrow posterodorsal wing is indistinctly recessed. The principal mode of variation in the right valve is in its degree of inflation. Normally, they are moderately and evenly inflated, with smooth, regular descents occurring to the valve margins (e.g. D.8215.11; Pl. 59, fig. 13). Nevertheless, some specimens are more strongly convex, with the maximum degree of inflation being concentrated along the growth axis (e.g. D.3862.6 and 8228.5; Pl. 59, figs. 2 and 4). There are even some indications of this variation being carried to the extreme form that has a convex ridge extending from the beak to the ventral margin with very steep drop-offs on either side (e.g. D.8214.29; Pl. 59, fig. 11). Such a form is similar to that described by Woods (1911, p. 267, pl. 46, figs. 8–10) in some specimens from the Blackdown Greensand and Hunstanton Red Limestone of England.

Owing to the poor state of preservation of many of the moulds the precise nature of the original ornament is difficult to define. Whenever traces of concentric ribs are present, on either valve, they always appear to be simple, narrow, regular, and closely spaced. Typically less than 1 mm wide and separated by interspaces of slightly greater dimensions, they may have either sharp or rounded summits (e.g. D.3862.6, 8214.31, 8227.5; Pl. 59, figs. 4, 5, 7). On some valves slightly coarser secondary ribs, with a 3–10 mm spacing, appear to be superimposed on the primary ones (e.g. D.8228.5 and 8413.58; Pl. 59, figs. 2, 3, 8) and there are some indications too, of both occasional growth pauses and irregularities.

A small number of internal moulds bear traces of up to five radial riblets (e.g. D.8214.27, 8215.25, 8228.13, 8413.38, 42; Pl. 59, figs. 9, 10). These have a maximum width of 1 mm and seem to radiate from the umbo to the ventral margin; however, it should be emphasized that they are nearly all weak and discontinuous. Some of the interspaces between them are slightly concave and as such can be described as sulci.

Remarks. Kauffman (1978*a*) suggested that this highly variable species may eventually be split into as many as six subspecies, but these have yet to be formally described. The stratigraphic control on the present collections does not permit such an approach here, and all the material is referred to a single taxonomic category.

Small to medium-sized elongate-pyriform whole specimens (e.g. D.3862.6, 8228.10, 20, 8413.58, 60; Pl. 59, figs. 3 and 4) as well as more obliquely elongated forms (e.g. D.8214.13 and 8227.5; Pl. 59, figs. 5 and 6) compare well with the majority of European specimens illustrated by Parkinson (1819, pl. 1, fig. 4), J. Sowerby (1821, pl. 305, figs. 1–6), Woods (1911, pl. 46, figs. 1–10; pl. 47, figs. 1 and 2) and Saveliev (1962, pl. 7, figs. 3–7; pl. 8, figs. 1 and 2). It is worth noting too that the latter two works illustrate collections with a range of variation comparable in scale, if not in precise detail, with the Antarctic material. The tendency towards a more pyriform outline of specimens such as D.8214.31 and 8228.5 (Pl. 59, figs. 2, 7, 8) can be matched to that of Woods's (1911, pl. 45, fig. 11) largest illustrated specimen and, probably, to Maury's (1936, pl. 8, figs. 9 and 10) subspecies *I. concentricus brasiliensis* (White) too.

The squatter, more rounded-quadrate Antarctic left valves (e.g. D.8413.38, Pl. 59, fig. 10) fit in less well with the traditional European concepts of *B. concentrica*. Nevertheless, they appear to grade into obliquely elongated forms and Kauffman (1978*a*, *b*; Wiedmann and Kauffman 1978) has shown how they can also be distinguished in both European and South African collections. Types such as specimen D.8413.38 closely resemble '*B. concentrica* n. subsp. 2' and associated forms from Spain (cf. Pl. 59, fig. 10 and Wiedmann and Kauffman 1978, pl. 1, figs. 3–6, 8–10, 13), and *B. concentrica brasiliensis* and '*B. concentrica* n. subsp. C' from South Africa (Kauffman 1978*b*, pl. 1, figs. 11, 16, 18). Kauffman's (1978*a*) '*B. concentrica* n. subsp. A', which is characterized by an anterior sulcus and a few coarse, widely spaced ribs, has no direct counterparts in the Antarctic collections. The European and South Africa '*B. concentrica* n. subsp. B', with its slanting and strongly projecting umbo (e.g. Kauffman 1978*b*, pl. 1, figs. 5 and 10), also seems to be missing, and it would appear that the bulk of the Antarctic specimens fall within Kauffman's (1978*a*, *b*) concepts of *B. concentrica concentrica* and the more quadrate forms, *B. concentrica brasiliensis* and '*B.* n. subsp. C'.

Birostrina? cf. *concentrica* Parkinson, 1819

Plate 59, figs. 12, 14; Plate 60, figs. 1–4; Plate 61, figs. 1–4

cf. 1846 *Inoceramus concentricus* J. Sowerby; d'Orbigny, p. 506, pl. 404, figs. 1 and 2.
cf. 1911 *Inoceramus concentricus* Parkinson; Woods, p. 265, pl. 45, fig. 11.
cf. 1914 *Inoceramus* aff. *concentricus* Parkinson; Spengler, p. 235, pl. 15, fig. 18.
cf. 1917 *Inoceramus concentricus* Parkinson; Woods, p. 9, pl. 3, figs. 9 and 10.
cf. 1936 *Inoceramus concentricus brasiliensis* (White); Maury, p. 107, pl. 8, figs. 9 and 10.
1972 *Inoceramus* aff. *concentricus* Parkinson; Thomson and Willey, p. 13, figs. 9*a* and 10.

Material. KG.1674.7 (int.m., WS); KG.103.181, 1609.16, 1675.2, 1681.6, 1721.23, 1746.7, 9, 1748.24, 2801.158, 182, 183, 206, 215, 218, 239, 262 (all int.m., LV); KG.1674.8 (?int.m., LV); KG.1663.35, 2801.180, 223 (all ext.m., LV); KG.103.158, 1674.6, 9, 1677.1, 1746.8, 2801.185, 207, 250, 256 (all int.m., RV); KG.1677.8, 1726.9*b* (both ?int.m., RV); KG.1677.3, 1674.5, 1680.74, 2801.150, 184, 214, 216 (all ext.m., RV). All the following localities are within the Fossil Bluff Formation of Alexander Island (text-fig. 2): KG.103/1681—upper levels, Waitabit Cliffs (71° 30′ 00″ S., 68° 14′ 30″ W.); KG.1609—westernmost nunatak, Hyperion Nunataks group (72° 02′ 30″ S., 68° 55′ 00″ W.); KG.1663—W side, Stephenson Nunatak (72° 08′ 30″ S., 69° 09′ 00″ W.); KG.1667—small nunatak immediately to NW Tethys Nunatak (72° 08′ 00″ S., 68° 59′ 30″ W.); KG.1674—small nunatak approximately 2 km SW Adams Nunatak (71° 08′ 00″ S., 68° 38′ 45″ W.); KG.1675—Adams Nunatak, Neptune Glacier (71° 44′ 00″ S., 68° 33′ 00″ W.); KG.1677—ridge between Mt. Lassell and Mt. Phoebe (71° 45′ 30″ S., 68° 49′ 00″ W.); KG.1680—lower levels, Keystone Cliffs (71° 33′ 00″ S., 68° 15′ 30″ W.); KG.1721—ridge running E of Mt. Phoebe (71° 47′ 00″ S., 68° 43′ 45″ W.); KG. 1726—ridge running SSW from Mt. Phoebe (71° 48′ 30″ S., 68° 48′ 00″ W.); KG.1746/1748/2801—upper levels, North Succession Cliffs (71° 08′ 30″ S., 68° 17′ 30 W.).

Occurrence. As for material. The age in the upper Waitabit Cliffs and lower Keystone Cliffs is almost certainly Albian (?Middle–Upper Albian) (text-fig. 10) (Willey 1972; Thomson 1974; Taylor *et al.* 1979); however, as previously mentioned, the presence of some ammonites with older (?Barremian) affinities at Waitabit Cliffs (Thomson 1983) has yet to be fully explained.

Description. These specimens show all the typical features of *B. concentrica*, except that they are somewhat larger. The respective mean shell lengths of the left and right valves, for example, are 89·77 mm (S.D. = 12·64; range = 68–114; N = 13) and 84·80 mm (S.D. = 19·31; range = 54–118; N = 10), and these values are significantly greater (Student's *t*-test, $p < 0{\cdot}001$) than the corresponding

EXPLANATION OF PLATE 60

Figs. 1–4. *Birostrina*? cf. *concentrica* (Parkinson) from the Fossil Bluff Formation of Alexander Island. 1, anterior view of internal mould of left valve (KG.1674.8); some prismatic shell material visible; small nunatak approximately 2 km SW of Adams Nunatak. 2, anterior view of internal mould of incomplete left valve (KG.2801.262); northern end of Succession Cliffs. 3, exterior view of the left valve of a whole specimen (KG.1674.7); small nunatak approximately 2 km SW of Adams Nunatak. 4, the same specimen, which is an internal mould, viewed from the right. All specimens × 1.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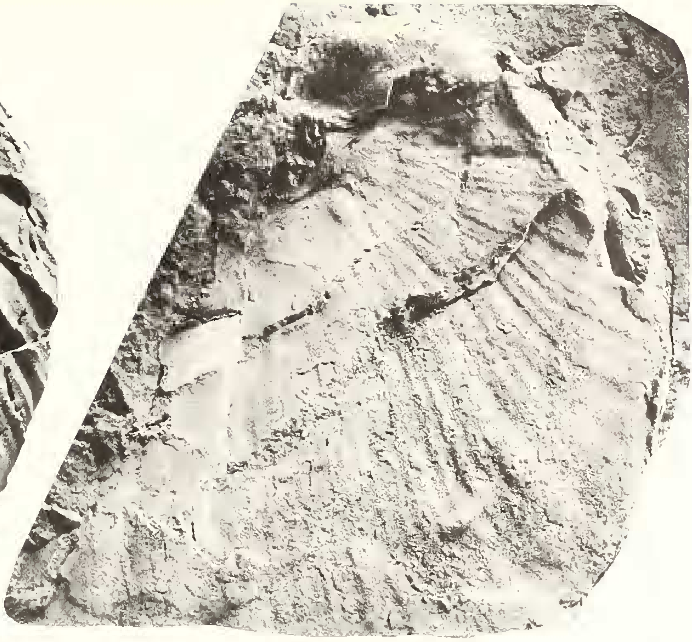
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CRAME, *Birostrina*? from Antarctica

ones (34·48 and 26·88) from the James Ross Island specimens. The foregoing measurements suggest that the degree of inequality between the valves may not be so great in the Alexander Island material but it should be emphasized that they are nearly all incomplete single valves. The one articulated specimen (KG.1674.7; Pl. 60, figs. 3 and 4) has a left valve of 100 mm length and a right of 76 mm and it is likely that this scale of difference may be close to the true value for the species.

The left valves consistently have obliquely oval to pyriform outlines and prominent, strongly enrolled umbones (e.g. KG.103.181, 1674.7, and 8, 2801.262; Pl. 60, figs. 1–3 and Pl. 61, fig. 2). They were moderately to strongly inflated, with the maximum convexity occurring in the central region along the growth axis. From the latter there was a very steep descent to the anterior margin and a somewhat gentler one towards the posterior. One specimen, however, is noticeable for its very steep descents to both the anterior and posterior margins; this gives it a markedly 'humpback' cross-profile (KG.1681.6; Pl. 61, figs. 3 and 4). The basic ornament pattern preserved on internal moulds of left valves is one of narrow (generally < 1 mm in width) closely and regularly arranged concentric ribs (e.g. KG.1674.7 and 2801.262; Pl. 60, figs. 2 and 3). On some specimens there is evidence of extremely fine ribbing on the early stages (e.g. KG.1674.7; Pl. 60, fig. 3), whilst on others somewhat coarser ones develop towards the ventral margin (e.g. KG.103.181; Pl. 61, fig. 2). There are also indications that secondary stronger ribs developed in certain specimens (e.g. KG.1674.8; Pl. 60, fig. 1), in a manner similar to that described for specimens D.8228.5 and 8413.58 (Pl. 59, figs. 2, 3, 8) from James Ross Island. These ribs have approximately 3–7 mm spacings and their sharper profiles rise significantly higher than those of the primary ribs. A small number of the internal moulds are almost smooth, their surfaces being broken only by occasional shallow concentric depressions which may indicate growth pauses (e.g. KG.1681.6; Pl. 61, figs. 3 and 4).

The right valve has an erect outline and a moderately to strongly prosogyrous umbo that scarcely rises above the level of the hingeline (e.g. KG.1674.7, 1680.74, 2801.250; Pl. 59, figs. 12, 14 and Pl. 60, fig. 4). Where preserved the anterior margin is seen to be a nearly straight feature that is equal in length to at least half the total valve length. It normally subtends an angle close to a right angle with the hinge, although some compressed specimens have values considerably greater than this (e.g. KG.103.158; Pl. 61, fig. 1). The anterior margin leads into well-rounded ventral and posteroventral margins but the posterodorsal border is somewhat straighter. The degree of inflation is considerably less than that of the left valve, with most of it being concentrated in the umbonal and central regions; the descents to the valve margins are correspondingly gentler, with only the anterior edge being sharply defined. Specimen KG.1674.7 (Pl. 60, fig. 4) has a narrow, smooth flange running along the anterior margin which tapers from approximately 9 mm in width at the ventral end to less than 3 mm beneath the umbo. This feature could be interpreted as an anterior wing but it is also possible that it represents a near vertical anterior edge that has collapsed on compression. The same specimen bears traces of a narrow, tapering posterodorsal wing but this is not a prominent characteristic of the right valve.

One right valve, KG.1674.6, is considerably more inflated than all the others. This inflation is concentrated in the dorsal half of the valve, especially along the growth axis. There are steep descents to both the antero- and posterodorsal margins and the overall form of the valve is similar to that of specimen D.8214.29 (Pl. 59, fig. 11) from James Ross Island. The fine regular ornament of the left valve is generally repeated on the right (e.g. KG.1680.74 and 2801.250; Pl. 59, figs. 12 and 14). There are occasional interruptions to the basic pattern caused by growth pauses or superimposition of the fine ribs on low primary folds (e.g. KG.1680.74; Pl. 59, fig. 12). Both rib width (which is generally

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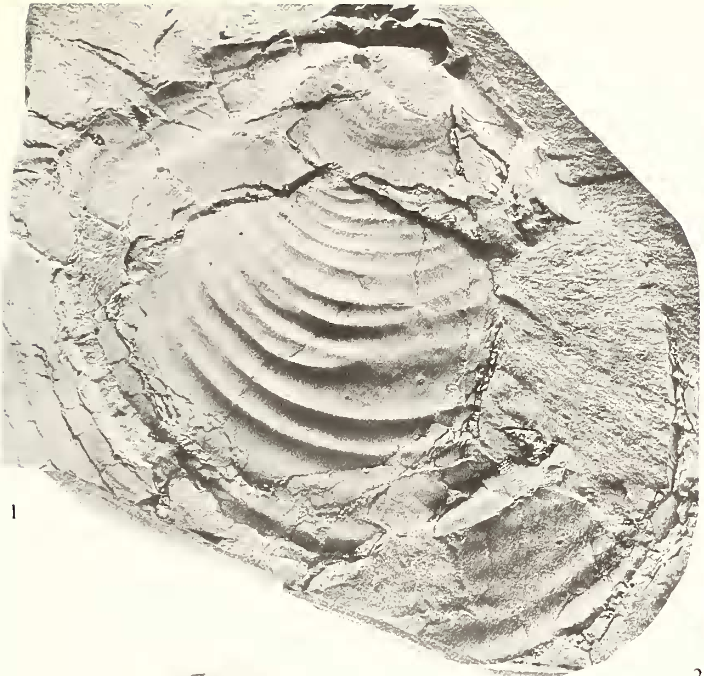
EXPLANATION OF PLATE 61

Figs. 1–4. *Birostrina*? cf. *concentrica* (Parkinson) from the Fossil Bluff Formation of Alexander Island. 1, internal mould of possible right valve (KG.103.158); Waitabit Cliffs. 2, anterodorsal view of internal mould of incomplete left valve (KG.103.181); same locality. 3, exterior view of internal mould of large left valve (KG.1681.6); same locality. 4, anterior view of same specimen. All specimens × 1.



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CRAME, *Birostrina*? from Antarctica

< 1·5 mm) and interspace width increase slightly towards the ventral margin. Notable variants include types such as specimen KG.103.158 (Pl. 61, fig. 1), which has acute, more widely spaced ribs that show some tendency to anastomose, and KG.1674.6, which is an almost smooth form bearing traces of fine radial striae. No obvious radial folds or sulci were observed on either valve.

Remarks. The strongly gryphaeoid form and regular concentric ornament link these specimens with *B. concentrica*. However, as their mean dimensions are considerably greater than those normally associated with this species, and their preservation rather poor, they are only tentatively assigned to it. There is a fairly close correspondence with the few known large forms of *B. concentrica* from Europe and Brazil (e.g. d'Orbigny 1846, pl. 404, figs. 1 and 2; Woods 1911, pl. 45, fig. 11; Maury 1936, pl. 8, figs. 9 and 10). The correspondence is less precise with the large specimens of '*I. concentricus*' from New Zealand (Woods 1917, pl. 3, figs. 9 and 10) as the latter have somewhat broader and more symmetrical left valves. Some specimens currently assigned to the New Zealand species, *I. warakius* Wellman (see Speden 1977, figs. 10-16), may well be a better match for the Antarctic material, but this taxon is currently in need of extensive revision. It certainly seems to possess a strongly graphaeoid form and probably forms part of a lineage of '*I concentricus*'-like forms which span the Albian-Cenomanian Motuan and Ngaterian stages. A left valve described by Spengler (1914, pl. 15, fig. 18) as *I.* aff. *concentricus* from the Lower Utatur Group of southern India shows some similarities to the Antarctic specimens but is less strongly inflated. In view of their size and apparent lack of radial ornament, all the foregoing large specimens can only be tentatively linked with *Birostrina*.

The affinity of specimen KG.103.158 (Pl. 61, fig. 1) to *B.*? cf. *concentrica* must be held in some doubt as it is both considerably broader (apical angle 128°) than any other right valve and bears sharper, more irregular ornament. It could just be closer to certain members of the *I. anglicus* group. There are some doubts too about the allegiance of specimen KG.1681.6 (Pl. 61, figs. 3 and 4), whose strongly inflated profile and almost smooth surface could be matched to Cenomanian species such as *I. corpulentus* from Canada (e.g. Warren and Stelck 1940, pl. 4, figs. 4-6) and *I. reduncus* from the Soviet Far East (e.g. Pergament 1966, p. 40, pl. 16, fig. 1*a*; pl. 18, figs. 1*a*, *b* and 2*a*) (see Table 1). However, no other Cenomanian fossils have yet been recognized in the Fossil Bluff Formation.

Genus *Anopaea* Eichwald, 1861

Type species. Inoceramus lobatus Auerbach and Frears (1846, p. 492, pl. 7, figs. 1-3) = *I. brachovi* Rouillier (1849, p. 439), from the Upper Jurassic of the Ural Mts., USSR; by monotypy (Cox 1969, p. N317).

Anopaea trapezoidalis (Thomson and Willey, 1972)

Text-fig. 9*a*

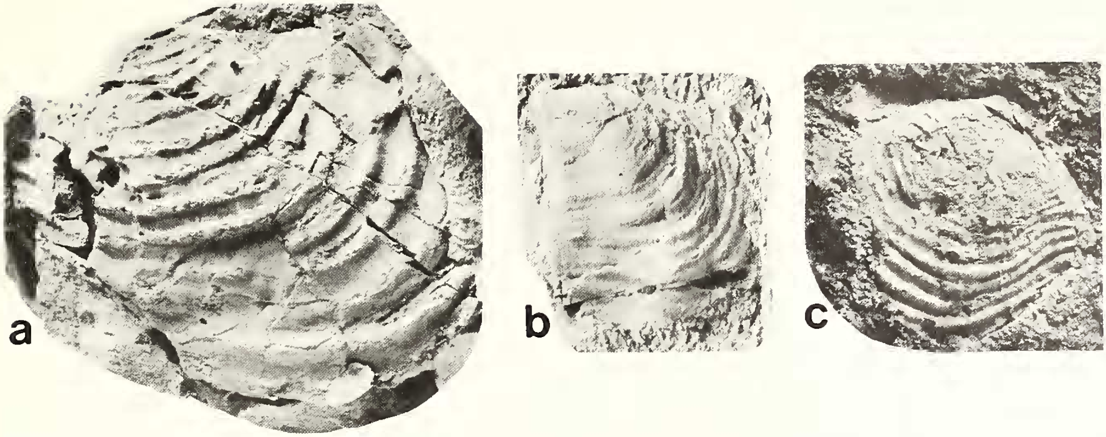
1972 '*Inoceramus*' *trapezoidalis* Thomson and Willey, p. 11, fig. 8*a*-*b*.
1981 *Anopaea trapezoidalis* (Thomson and Willey); Crame, p. 215, pl. 2, figs. *a*-*d*.

Holotype. KG.18.31*a* (int.m., LV) from the Fossil Bluff Formation of Alexander Island; illustrated in Thomson and Willey (1972, fig. 8*a*) and Crame (1981, pl. 2, fig. *a*); by original designation.

Additional material. KG.2880.225, 293, 296 (all int.m., LV); KG.1745.10 (ext.m., LV); KG.1745.11 (ext.m., RV). Both localities are in the Fossil Bluff Formation of Alexander Island (text-fig. 2): KG.1745—locality U, 2 km NW of Fossil Bluff (71° 18′ S., 68° 20′ W.); KG.2800—locality Q, Fossil Bluff (71° 19′ S., 68° 17′ W.). The specimens at the latter locality occur between 88·5 and 111·0 m in a 426 m section (text-fig. 10).

Occurrence. As for material. Previously regarded as Berriasian in age (Crame 1981, fig. 5), it is now apparent that *A. trapezoidalis* may be, in part at least, as young as Aptian (Crame 1983*a*).

Description and remarks. Specimens KG.1745.10 and 11, with shell lengths (as measured from anterior to posterior extremities) in the region of 15 mm, and specimen KG.2800.295, with a length of approximately 32 mm, closely resemble the smallest members of this species previously described from locality K (Thomson and Willey 1972, fig. 8*b*; Crame 1981, pl. 2, figs. *b*-*d*). The two smallest specimens bear traces of a distinct anterior sulcus and specimen KG.2800.293, although lacking this



TEXT-FIG. 9. *Anopaea* from the Antarctic Peninsula region. *a*, incomplete internal mould of a large left valve of *A. trapezoidalis* (Thomson and Willey) (KG.2800.255); specimen from Fossil Bluff, Alexander Island. *b*, incomplete internal mould of a left valve of *A.* sp. nov. aff. *mandibula* (Mordvilko) (KG.1682.37); specimen from Waitabit Cliffs, Alexander Island. *c*, internal mould of a right valve of *A.* sp. nov. β (D.8212.261) from a locality approximately 1·5 km ENE of Stoneley Point, NW James Ross Island. All specimens $\times 1$.

feature, has the remnants of a very deep anterior lunule. Specimen KG.2800.225 (text-fig. 9*a*) is similar in general form to the holotype (KG.18.31*a*; Thomson and Willey 1972, fig. 8*a*; Crame 1981, pl. 2, fig. *a*), but slightly larger. It has a very high, rounded posterior region and much narrower anterior, and, like the holotype, lacks a clearly defined anterior sulcus. This seems to be a characteristic of the largest individuals of this species, as is the presence of coarse concentric ornament. On specimen KG.2800.225 (text-fig. 9*a*) the ribs are in the region of 3 mm apart over the centre of the valve and 5 mm apart towards the ventral margin. Specimen KG.2800.296 is a very incomplete large left valve with a height in the posterior region of about 65 mm and an estimated length of 80 mm. It is covered with closely set, coarse concentric ribs separated by deep interspaces.

Anopaea sp. nov. aff. *mandibula* (Mordvilko, 1949)

Text-fig. 9*b*

cf. 1962 *Inoceramus mandibula* Mordvilko; Saveliev, p. 230, pl. 6, figs. 1–11.

Material. KG.1682.37 (int.m., LV), from a high level in Waitabit Cliffs, Alexander Island (71° 30′ 00″ S., 68° 14′ 30″ W.; text-figs. 2 and 10).

Occurrence. As for material. Albian (?Middle–Upper Albian), from its position at a high level in Waitabit Cliffs.

Description. The estimated length of this specimen is 35 mm and the maximum height (dorsal to ventral margins) is 32 mm. Although most of the anterior region is missing it can be judged to have been much narrower than the posterior with a height of approximately 17 mm. The well-rounded posterior region can be traced forward into a short, straight hinge which is partially obscured by the strongly prosogyrous umbo. The latter terminates in a narrow, pointed beak which overhangs a deeply excavated anterodorsal lunule (text-fig. 9*b*). The ventral margin is slightly sinuous due to the presence of a broad, shallow sulcus of some 12 mm width in its mid-region. This sulcus can be traced right up into the beak where it sweeps forwards and narrows to just under 2 mm in width (text-fig. 9*b*). The weakly to moderately inflated valve surface is covered with narrow (predominantly < 1 mm in width) concentric ribs that are regularly spaced but somewhat variable in their intensity; some tend to fade across the sulcus and others in the posterodorsal region (text-fig. 9*b*). Slightly coarser ribs approaching 1 mm in width and separated by interspaces of up to 2 mm occur close to the ventral margin.

Remarks. The form of this specimen is too rounded and the ornament too fine for it to be related to *A. trapezoidalis*. It would seem instead to be closer to *A. mandibula* (Mordvilko) from the Lower Albian of Mangishlak (Saveliev 1962, p. 230, pl. 6, figs. 1–11). This is an erect, moderately inflated and finely ribbed species whose left valve can be closely matched with the Alexander Island specimen. However, there may be some differences between the two (especially in the form of the anterior sulcus) and specific separation seems to be necessary. *B. salomoni* (d'Orbigny) also has a strongly sulcate left valve, but this is typically more rounded-rectangular in outline and bears a broad, orthogyrous umbo (e.g. Woods 1911, pl. 45, figs. 3–7; Saveliev 1962, pl. 9, figs. 6–9).

Anopaea sp. nov. β

Text-fig. 9*c*

Material. D.8212.261 (int.m., RV); D.8212.262 (int.m., LV). Locality D.8212—valley floor approx. 1·5 km ENE of Stoneley Point, James Ross Island (63° 51′ 40″ S., 58° 05′ 20″ W.; text-fig. 3); the specimens originate from approximately the 980 m level in the combined section measured on NW James Ross Island (text-fig. 11).

Occurrence. As for material. Aptian–Albian, from its association with *I. stoneleyi* sp. nov. and probable silesitid ammonites.

Description. The right valve (D.8212.261; text-fig. 9*c*) has an extremely accentuated rounded-wedge shaped profile; over a length of 23 mm it tapers from a height of 23 mm in the posterior region to approximately 8 mm at the anterior. The straight hinge has a length of 10 mm and subtends an angle of 140° with the anterior margin. It leads posteriorly into what appear to have been well-rounded posterior and posteroventral margins and these in turn pass into an anteroventral region whose outline is interrupted by a broad, shallow sinus (text-fig. 9*c*). Although incomplete, it would appear that the latter region was extremely narrow and pointed. A slender, tapering posterodorsal wing with a height at its posterior end of 2 mm and a concave cross-section is sharply demarcated from the main surface of the valve. Ornament consists of narrow (< 1 mm), regular concentric ribs separated by flat interspaces of 1·0–1·5 mm width (text-fig. 9*c*).

Remarks. Although there are some similarities in style of ornament between these specimens and the Tithonian species, *A. stoliczkai* (Holdhaus) (Crame 1981, pl. 1, figs. *a–f*), they differ significantly in shell form. In particular, specimen D.8212.261 (text-fig. 9*c*) has a less deeply excavated lunule but more prominent anterior sulcus. There are differences too in shell form from *A. trapezoidalis*, and in style of ornament from *A.* sp. nov. aff. *mandibula*.

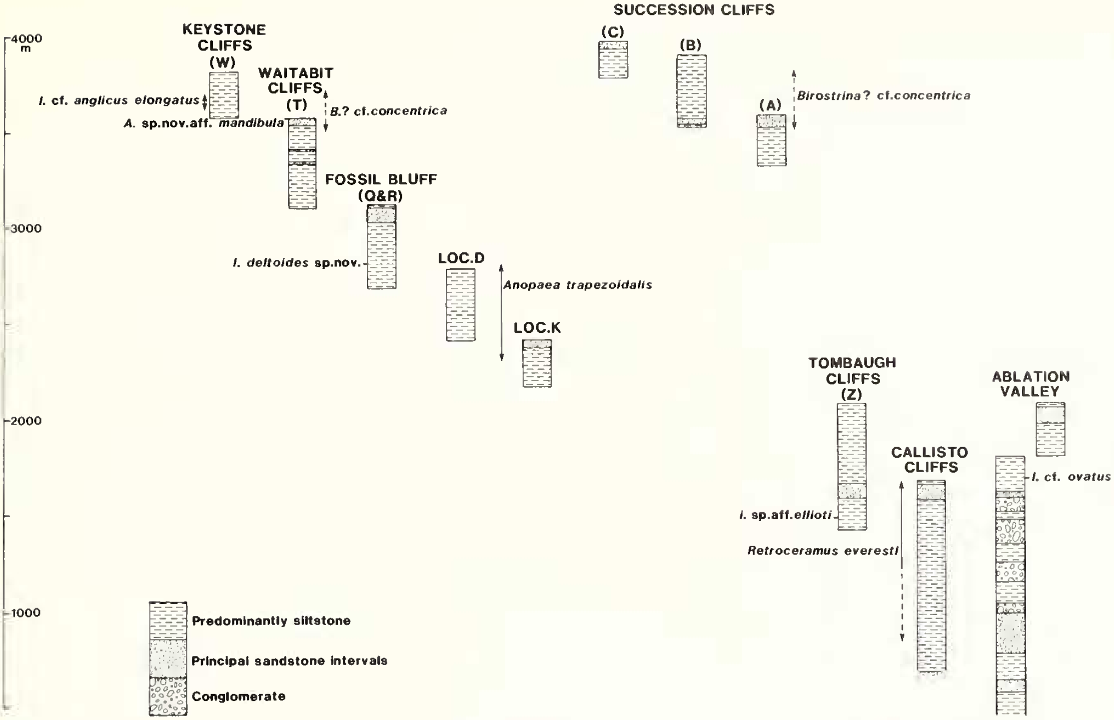
This material most likely represents a new species. The suffix β is used as a new but unnamed species of *Anopaea* has already been described from probable Upper Jurassic strata within the Fossil Bluff Formation (Crame 1981, p. 213).

STRATIGRAPHIC DISCUSSION

Alexander Island

Preliminary accounts of the distribution of Lower Cretaceous inoceramid bivalves through the Fossil Bluff Formation have already been given (Crame 1983*a*, *b*). In these works a simplified stratigraphic correlation scheme was presented for a series of major localities between Ablation Point and Keystone Cliffs (text-fig. 2; Crame 1983*a*, fig. 3; 1983*b*, fig. 2); these were thought to comprise the greater part of the Fossil Bluff Formation and total approximately 3820 m in thickness. With the more detailed taxonomic and stratigraphic information given in this study, it is necessary to briefly re-examine these distributions and further assess their stratigraphic implications.

In the lower levels of Tombaugh Cliffs and highest parts of Callisto Cliffs (text-fig. 10), *Retroceramus everesti* is of Berriasian age (Crame 1982). It is probably also present towards the top of



TEXT-FIG. 10. Occurrence of Lower Cretaceous inoceramids in the Fossil Bluff Formation of Alexander Island. Localities given in text-fig. 2. Correlations based in part on Taylor *et al.* 1979, fig. 6 and Crame 1982, text-fig. 9. Vertical scale in metres (lowest 500 m omitted).

the main Ablation Valley section and it is thought that the uppermost limit of its range can be set at 1675 m. Thus, it overlaps with the occurrences of *I.* sp. aff. *ellioti* (1480 m) and *I.*cf. *ovatus* (1675 m) (text-fig. 10), both of which have also been well established as Berriasian (Taylor *et al.* 1979; Crame 1983*a*, *b*). Moving southwards, structural, lithological, and faunal considerations all suggest that the top of the Tombaugh Cliffs section correlates with a level slightly beneath the base of the section at locality K (text-fig. 10). The next inoceramid to appear in the sequence, *A. trapezoidalis*, commences in the mid-levels of the section at locality K (2300 m) and continues upwards through locality D to the 2810 m level at localities Q and R (text-fig. 10). The extension of the range of this species into the base of the Fossil Bluff sections means that it may be, in part at least, as young as Aptian in age; indeed, it is even possible that it is also Aptian at locality K, as was originally suggested by Thomson and Willey (1972). At present there is no palaeontological evidence for the age of the beds occurring between *I.* cf. *ovatus* and *A. trapezoidalis* (text-fig. 10).

I. deltoides sp. nov. at the 2800–2820 m level (text-fig. 10) is most likely Aptian in age, although previous comments about possible late Neocomian or Barremian affinities of certain heteromorph ammonites occurring above it should be borne in mind. If various ammonite species of the genera *Aconeceras*, *Theganeceras*, and *Sanmartinoceras*, and belemnites of the genera *Peratobelus* and *Neohibolites*, are taken as Aptian (Taylor *et al.* 1979), then it would appear that this stage is well represented in the sections at localities Q and R and in the lower levels of Waitabit Cliffs (text-fig. 10). The transition up into the Albian seems to occur at the latter locality with specimens of *B.*? cf. *concentrica* (3500–3700 m) and *Eotetragonites* being taken as indicators of the younger stage. Notwithstanding the possible Barremian affinities of ammonites such as *Antarcticoceras* and *Silesites*

(Thomson 1983), both *Anopaea* sp. nov. aff. *mandibula* (3560 m) and *I.* cf. *anglicus elongatus* (3620–3680 m) are also taken to be Albian (?Middle–Upper Albian) in age (text-fig. 10).

The gradual southerly younging of the Fossil Bluff Formation between Ablation Valley and Fossil Bluff is interrupted by the abrupt occurrence of Albian strata at localities A, B, and C, Succession Cliffs (text-figs. 2 and 10). These beds, which have yielded *B.*? cf. *concentrica* together with ammonites such as *Antarcticoceras antarcticum* Thomson and *Ptychoceras* sp., are thought to have been emplaced by a combination of thrusting and normal faulting (Taylor *et al.* 1979). Further evidence of stratigraphic repetition of the Fossil Bluff Formation by faulting is provided by the recurrence of both *I. deltoides* sp. nov. and *B.*? cf. *concentrica* at several localities between the Neptune Glacier and Stephenson Nunatak (text-fig. 2). The exact stratigraphic positions of *I. flemingi* sp. nov., *I.* sp. aff. *bellvuensis*, and *I.* sp. aff. *comancheanus* are uncertain but it is assumed that they occupy a level at least as high as that of *B.*? cf. *concentrica* (text-fig. 10).

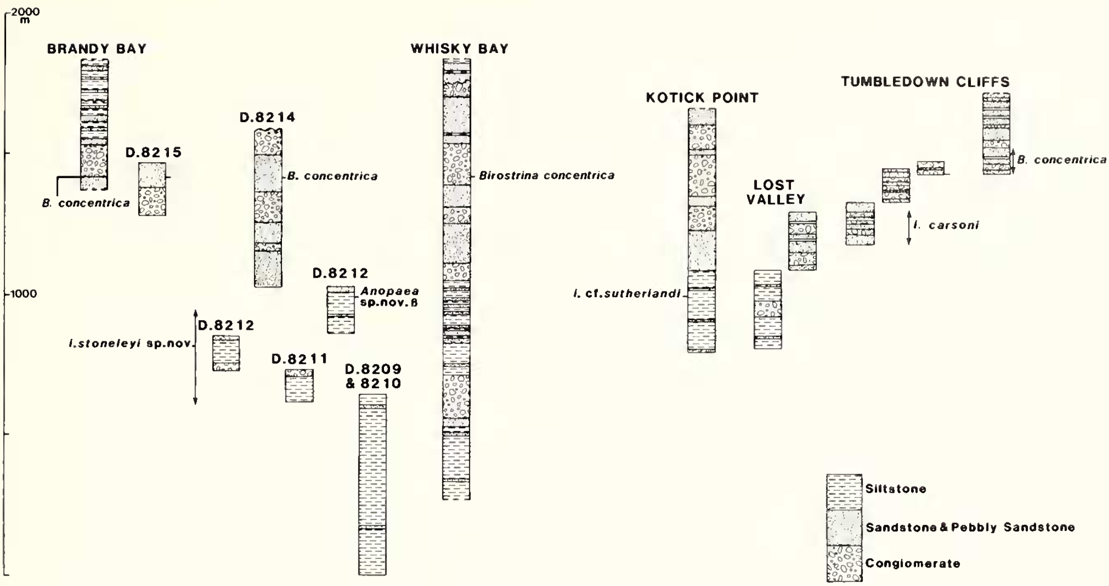
James Ross Island

The Lower Cretaceous biostratigraphy established for the Brandy Bay–Whisky Bay region (Crame 1983*a*, *b*) can now be extended to the Gin Cove–Rum Cove area (text-fig. 3). This correlation is based primarily on the occurrence of *B. concentrica*, which, although unrecorded in poorly exposed strata at Kotick Point, is present in both the North and South Tumbledown Cliffs sections (text-figs. 3 and 11). It is enhanced by certain broad lithological comparisons between the two regions and by similar levels of occurrence of the ammonite provisionally identified as *Silesites*.

I. stoneleyi sp. nov. (previously identified as a member of the *I. neocomiensis* group—Crame 1983*a*, *b*) occurs in the combined section between approximately 600 and 925 m (text-fig. 11). Associated fossils, such as '*Ancyloceras*' *patagonicum*, small aconeceratids and *Aucellina*, suggest an Aptian–Albian age, as do close relatives within the *I. liwerowskyae* group; nevertheless, the possibility that at least some ancyloceratids and aconeceratids may be Barremian (or even older) in Alexander Island should be considered in any final age-determination of these beds. To date the only fossils collected from the lowest 600 m of strata on James Ross Island are a series of juvenile buchiid/oxytomid bivalves and a small gaudryceratid ammonite. If the beds containing *I. stoneleyi* sp. nov. are confirmed as Aptian–Albian, then this lowest biostratigraphic unit (text-fig. 11) may well prove to be Barremian or even earlier in age.

Anopaea sp. nov. β from the 980 m level at locality D.8212 (text-fig. 11) is also judged to be Aptian–Albian. The silesitid ammonites with which it is associated can be traced again at the 900–1000 m level in the Kotick Point section (text-fig. 11). Other fossils occurring in the lower half of the Kotick Point section include occasional phylloceratid and lytoceratid ammonites, *Aucellina* and *I.* cf. *sutherlandi*; the latter species in particular has been used to assign an undifferentiated Aptian–Albian age to this interval. *Inoceramus carsoni*, an Upper Albian species in Australia, occurs in the Lost Valley and North Tumbledown Cliffs sections between 1140 and 1250 m (text-fig. 11). Throughout this range it is associated with a species of *Aucellina* close to *A. hughendenensis* and a so far unidentified species of *Maccoyella*. The heteromorph *Ptychoceras* (Upper Aptian–Upper Albian) has been recorded from the top of the Lost Valley section and a probable specimen of *Beudanticeras* (Lower–Upper Albian) from an equivalent stratigraphic level nearby (M. R. A. Thomson, pers. comm.). Neither *I.* cf. *sutherlandi* nor *I. carsoni* has yet been found in the Brandy Bay–Whisky Bay region, where the 1000–1300 m interval is predominantly composed of unfossiliferous conglomeratic beds.

B. concentrica occurs in the combined section at approximately the 1375 m level (text-fig. 11). The Middle–Upper Albian age for this species established in other regions would seem to be confirmed by its position above *I. carsoni* and its association at North Tumbledown Cliffs and locality D.8414 (text-figs. 3 and 11) with turrilitid ammonites (M. R. A. Thomson, pers. comm.). At South Tumbledown Cliffs there appears to be a regular transition upwards from the *B. concentrica* beds into Cenomanian strata characterized by acanthoceratid ammonites and probable members of the *I. pictus* Sowerby group (M. R. A. Thomson, pers. comm.). However, at all other localities so far investigated the Lower–Upper Cretaceous boundary is obscured by poorly exposed conglomeratic strata and local unconformities (Crame 1983*b*).



TEXT-FIG. 11. Occurrence of Lower Cretaceous inoceramids on the NW coast of James Ross Island. Localities given in text-fig. 3. Correlations based in part on unpublished information kindly supplied by J. R. Ineson. Vertical scale in metres.

Annenkov Island and South Georgia

Comparisons with similar forms suggest that the most likely age affinities of both *I. annenkovensis* sp. nov. (= *I.* cf. *anomiaeformis* of Crame 1983*a*) and *I.* cf. *heteropterus* from the Lower Tuff Member of the Annenkov Island Formation are Hauterivian–Barremian. Nevertheless, it should be emphasized that these comparisons are somewhat tenuous and the precise age of the sediments on this island remains in some doubt. A slightly younger age (Barremian or Aptian) age is suggested by the poorly preserved specimens of aconeceratid ammonites and *Aucellina* that occur in the upper levels of the range of *I. annenkovensis* sp. nov. (Crame 1983*a*, figs. 6 and 7), but there are also a number of other faunal elements in both the Lower Tuff and Upper Breccia Members whose significance is as yet uncertain (Thomson *et al.* 1982). There is still considerable scope for clarification of the biostratigraphy of Annenkov Island.

Only a single indeterminate specimen of *Inoceramus* has been recorded from the Cumberland Bay Formation of South Georgia (Thomson *et al.* 1982, p. 178).

SYNTHESIS

Berriasian representatives of the *I. ovatus* group (*I.* cf. *ovatus* and *I.* sp. aff. *ellioti*) from Alexander Island provide a possible means of correlation between the earliest Cretaceous strata of Antarctica and those of the Pacific coast of North America and Siberia. Moving up through the succession of Antarctic Lower Cretaceous inoceramids, it is apparent that there is then a pronounced stratigraphic gap before the probable Aptian–Albian faunas of the upper Fossil Bluff Formation and the lower part of the James Ross Island succession. There is very little evidence of Valanginian, Hauterivian, or Barremian inoceramids. Of course this time interval may be at least partially filled in the Fossil Bluff Formation when taxonomic revisions of certain ammonites (notably the heteromorphs) have been undertaken and stratigraphic studies at localities AP and CC2 (text-fig. 2) completed. Nevertheless, at present, there is very little firm palaeontological evidence for the Valanginian–Barremian stages in

Alexander Island. *Anopaea trapezoidalis* (text-fig. 10) may be late Neocomian or Barremian in the early part of its range but this has yet to be confirmed.

Although the Cretaceous sedimentary succession in the James Ross Island area is thought to commence at approximately the Aptian stage, there is evidence of lower stratigraphic horizons at at least two localities on the east coast of the Antarctic Peninsula. Late Hauterivian–Barremian dinoflagellates and coccoliths have been recovered from a 750–1000 m conglomeratic sequence on the Sobral Peninsula (text-fig. 1), and at Pedersen Nunatak (text-fig. 1) a 142 m sequence of conglomerates and sandstones has yielded ammonite fragments referable to the South American Hauterivian species, *Favrella wilckensi* (Favre) (Farquharson 1982; Thomson and Farquharson 1984). Further north, *I. annenkovensis* sp. nov. and *I.* cf. *heteropterus* from the Lower Tuff Member of Annenkov Island have Hauterivian–Barremian affinities. The latter species in particular, through its link with a distinctive North Pacific inoceramid group, suggests an Upper Hauterivian age, but balanced against this is the presence of both aconeceratid ammonites and *Aucellina* in the same stratigraphic unit. Perhaps the best compromise is to regard the age of this unit as Barremian. Early Cretaceous marine sediments on Byers Peninsula (South Shetlands) are probably confined to the Berriasian and Valanginian (Smellie *et al.* 1980) but isolated marine intervals within the Mesozoic alluvial fan conglomerates of the South Orkney Islands (text-fig. 1) may range as high as the Hauterivian (Thomson 1981).

The paucity of Valanginian–Barremian inoceramids from the Antarctic Peninsula region as a whole enhances the impression of a general hiatus at this time gained from the study of other faunal groups (notably the ammonites, e.g. Thomson 1974, 1982). This may well be linked with a significant marine regression as the Antarctic Peninsula underwent a major phase of uplift and magmatic activity (Farquharson 1982). It has been suggested that the simplest explanation of this orogenic pulse was an increased rate of subduction of the Pacific Aluk plate beneath the Antarctic Peninsula margin of Gondwana. Such an event is thought to have been a likely precursor to the Valanginian opening of the South Atlantic and Weddell Sea basins (Farquharson 1983).

I. stoneleyi sp. nov., the lowest species to occur in the James Ross Island succession, can be matched with Aptian–Albian members of the *I. liwerowskyae* group from Spitsbergen, south-western USSR, and the far-eastern USSR. Similarly, *I. deltoides* sp. nov. from the Fossil Bluff Formation is close to specimens of *I. subneocomiensis* and *I. neocomiensis* known from a number of Northern Hemisphere localities. The *I. neocomiensis* group is a particularly interesting one in that it may be one of the earliest Cretaceous inoceramid groups with a cosmopolitan distribution. It is succeeded by the *B. concentrica* group which is truly worldwide in its occurrence. The Middle–Upper Albian age of *B. concentrica* on James Ross Island is supported by ammonites and this species is generally regarded as one of the most useful for both local and regional correlations in the Antarctic Lower Cretaceous. On Alexander Island the presence of *B.*? cf. *concentrica* in the Waitabit Cliffs and Keystone Cliffs sections suggests that a general correlation can be made between the uppermost levels of the Fossil Bluff Formation and the 1375 m level on James Ross Island (text-figs. 10 and 11).

Other high level inoceramids in the Fossil Bluff Formation include *I. flemingi* sp. nov., a probable member of the *I. liwerowskyae* group, and three species (*I.* cf. *anglicus elongatus*, *I.* sp. aff. *bellvuensis*, and *I.* sp. aff. *comancheanus*) that have their strongest affinities with the cosmopolitan *I. anglicus* group. Both the latter three and *I.* sp. aff. *anglicus* from Dundee Island can be compared with specimens from a wide range of Northern Hemisphere localities. Representatives of the *I. carsoni* group in the James Ross Island succession provide a direct link between the Antarctic Peninsula and Great Artesian Basin of Australia; in particular, *I. carsoni* indicates a correlation of the 1140–1250 m interval with stratigraphic units such as the Allaru Mudstone of Queensland (Day 1969). *Anopaea* sp. nov. aff. *mandibula* may furnish another connection between the Aptian–Albian Fossil Bluff Formation faunas and those of the south-western USSR.

The Fossil Bluff Formation apparently terminates in the Albian (Taylor *et al.* 1979), but the James Ross Island succession passes up into Cenomanian and younger beds (Crame 1983*b*).

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My colleagues Dr. M. R. A. Thomson, Mr. J. R. Ineson, and Dr. G. W. Farquharson offered constructive criticisms of a number of points raised in the text. Dr. B. Haigh (Cambridge) translated some of the cited Russian material and Mr. C. Gilbert of the British Antarctic Survey took the photographs.

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